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Behavioral Determinants of Exercise-Related Injury Prevention Program Participation

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BEHAVIORAL DETERMINANTS OF EXERCISE-RELATED INJURY PREVENTION PROGRAM PARTICIPATION

by

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ABSTRACT

BEHAVIORAL DETERMINANTS OF EXERCISE-RELATED INJURY PREVENTION PROGRAM PARTICIPATION

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Lower extremity injuries are common among the physically active population. There are many negative consequences associated with these injuries which have led to a shift in clinical practice towards prevention. Exercise-related injury prevention programs (ERIPPs) were created to prevent musculoskeletal injuries that occur due to participation in physical activity. However, one of the major limitations to their effectiveness is the compliance of the users to complete the prescribed exercises. It is imperative to better understand the reasons why compliance is low to develop implementation strategies and improve compliance rates.

The overarching purpose of this dissertation was to gain a better understanding of why compliance with ERIPPs is low and to develop an intervention to improve attitudes towards ERIPPs. The first purpose of this dissertation was to perform a systematic review to identify the social or behavioral theoretical models or frameworks being used within ERIPP research and identify the level of theory implementation in study design (Project IA). The second purpose was to review the literature to determine how the Health Belief Model (HBM) and Theory of Planned Behavior (TPB) could be applied to ERIPP research (Project IB). The third purpose was to develop scales based on the HBM and TPB to assess behavioral determinants of ERIPP participation and pilot those scales (Project II). The fourth purpose was to confirm the psychometric properties of the HBM and TPB scales (Project III). The fifth purpose was to

evaluate the effectiveness of an intervention based on the HBM to change attitudes towards ERIPP participation and functional performance (Project IV).

The systematic review (Project IA) determined that the HBM and TPB were the most commonly utilized theoretical models in ERIPP research. Project II determined the subscales of the HBM and TPB scales had mostly acceptable internal consistencies, but select subscales required further evaluation. Project III confirmed the psychometric properties of the HBM and TPB scales with all of the subscales having acceptable internal consistency. Project IV provided evidence that an intervention based on the HBM could improve individual and community led self-efficacy as well as lead to improvements in functional performance.

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CHAPTER I

INTRODUCTION

Background

Lower extremity injuries are common among the physically active population. Up to 50% of all collegiate athletic injuries occur in the lower extremity.[1] Two of the more common lower extremity injuries are ankle sprains and anterior cruciate ligament (ACL) tears. Ankle sprain injuries account for up to 14%[1,2] and 23%[3] of all collegiate and high school athletic injuries respectively. Additionally, more than 2,000 ACL tears occur per year within collegiate athletics.[1] These common lower extremity injuries are associated with long term negative consequences such as a decreased health related quality of life[4] and osteoarthritis.[5] In conjunction with the physical consequences of these injuries, there are substantial economic impacts. The lifetime cost of treatment of an ankle sprain injury ranges up to $12,000.[6,7] ACL tears are likely to result in surgical repair producing costs ranging from $12,000-38,000[8,9] with costs of approximately $88,000 when rehabilitation alone was the treatment of choice.[9]

Due to the negative physical, psychological, and economic impacts of these injuries, movement towards preventing these injuries has gained traction. Exercise-related injury prevention programs (ERIPPs) have been developed to aid in the prevention of lower extremity injuries in physically active populations. ERIPPs focus on improving balance, range of motion, strength, and agility to prevent lower extremity injuries from occurring; particularly in sporting and athletic environments. Neuromuscular ERIPPs have been effective at preventing both ankle and ACL sprains.[10] However, one of the major limitations of ERIPP effectiveness is compliance of the users to perform the prescribed exercises.[11,12] The rationale for low adoption and poor

compliance with ERIPPs is nknown but overcoming poor compliance could greatly enhance the impact of these programs.

Social and behavioral theoretical models have been used to better understand the adoption of preventative health behaviors. The Theory of Planned Behavior (TPB) and the Health Belief Model (HBM) have been utilized to understand the behavioral determinants of participation in mammography screenings, vaccine uptake, and bicycle helmet use.[13-15] However, the use of these theories within exercise related injury prevention has been minimal. Theoretical models have only been mentioned in approximately 11% of all injury prevention studies.[16] Within that percentage, only 4 studies actually tested a theoretical model. A majority of the studies used theory to guide program design or measured one specific construct of a theoretical model.[16] None of the studies that were focused towards the use of ERIPPs included theoretical models. There is a potential that utilizing theoretical models; such as the TPB and HBM, within ERIPP research will aid in a better understanding of the reasons for low compliance from the user's perspective. Additionally, further insight on strategies to improve compliance may be gained while using these theoretical models to evaluate behavioral determinants of ERIPP participation.

Health Belief Model

The HBM contains six constructs thought to directly predict participation in a preventative health behavior.[17] The six constructs are: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy. Perceived susceptibility is defined as the individual's beliefs about their potential to be injured while perceived severity would be the individual's beliefs regarding the possible severity of an injury they would sustain. Perceived benefits are described as anything the individual believes they would gain from participating in the preventative health behavior. In the instance of ERIPP

participation, individuals who value participation in these programs may believe they will have a lower risk of lower extremity injury, improve performance, and improve knowledge regarding lower extremity injuries and injury prevention strategies. Perceived barriers are described as any obstacles an individual believes they may face when trying to participate in an ERIPP. The most commonly reported barriers are time, cost, and location of the ERIPP. Cues to action could be any reminder to participate in an ERIPP. Some examples may include a physician's recommendation to participate in an ERIPP or a friend sustaining an injury. Self-efficacy involves the individual's beliefs regarding whether they are capable of participating in an ERIPP. Some factors that could influence self-efficacy could be practicing the recommended exercises with a health care professional or watching another individual with common characteristics participate in the ERIPP.

Theory of Planned Behavior

The TPB has three constructs that are thought to indirectly predict participation in a preventative health behavior through intention to participate.[18] Intention is thought to be highly correlated to participation. The three constructs are attitudes, subjective norm, and perceived behavioral control. Attitudes are described as the beliefs regarding ERIPPs such as whether they view the program as beneficial, useful, fun etc. Subjective norms are described as the beliefs of other important individuals in the person's life towards ERIPPs. Some examples of important individuals would be coaches, parents, teammates, physicians. For example, if the athletic team an individual played on was participating in an ERIPP then the individual would be more likely to participate in an ERIPP. The beliefs of the individual regarding whether they have the ability to participate in an ERIPP is defined as perceived behavioral control.

The Problem

Exercise-related injury prevention programs are effective at reducing injuries when adoption and compliance is high among end users. However, adherence of ERIPPs is often low which jeopardizes the effectiveness of the program to prevent injuries. Educational interventions have been able to improve attitudes towards ERIPPs, but the improvement was not statistically significant. Additionally, the intervention have not led to improvements in participation in ERIPPs.[19,20] Utilizing theoretical models to evaluate behavioral determinants towards ERIPPs may allow for a better understanding of the reasons for poor compliance and identify intervention strategies to improve compliance. However, it is unknown if an intervention grounded in theoretical models will improve behavioral determinants of ERIPP participation and compliance.

Purpose

There were many purposes of this dissertation to begin gaining a better understanding of compliance with ERIPPs and begin the development of implementation strategies to improve attitudes towards ERIPPs as well as compliance. The first purpose was to systematically review the literature to determine the social or behavioral theoretical models or frameworks which have been used within ERIPP related research as well as identify the level of theory implementation. The second purpose was to evaluate the potential use of the HBM and TPB to gain a better understanding of why compliance with ERIPPs was low. The third purpose was to develop scales to assess the constructs of the HBM and TPB in relation to ERIPP participation. The fourth purpose was to confirm the factor structure of the HBM and TPB scales within a physically active population containing collegiate athletes, club sport athletes, and recreational

athletes. The fifth purpose was to examine the effectiveness of an intervention based on the HBM to change the behavioral determinants of ERIPP participation and functional performance within club sport participants.

Experimental Aims and Hypotheses

Aim 1: Develop scales which assess the constructs from the TPB and HBM as behavioral determinants of ERIPP participation.

Hypothesis for Aim 1: The subscales of the HBM and TPB scales will have acceptable internal consistency within a population of physically active adults.

Aim 2: Perform an exploratory factor analysis to examine the structure of the HBMS and TPBS.

Hypothesis for Aim 2 (A): The structures of the HBMS and TPBS will identify the constructs associated with those models.

Hypothesis for Aim 2 (B): The subscales formed within the HBMS and TPBS will have acceptable internal consistency.

Aim 3: Compare the behavioral determinants of ERIPP participation before and after an intervention based on the Health Belief Model within club sport participants.

Hypothesis for Aim 3 (A): Behavioral determinants towards ERIPP participation will be more positive following the intervention.

Hypothesis for Aim 3 (B): The positive changes following the intervention will remain at the follow-up measure.

Aim 4: Evaluate whether an intervention based on the Health Belief Model leads to improvements in functional performance (anterior reach of Y-Balance Test, Landing Error Scoring System) within club sport participants.

Hypothesis for Aim 4: Functional performance will improve following an intervention based on the HBM.

Clinical Implications

The strategy utilized by most clinicians for injury prevention has been homogenous for all types of physically active individuals. The results from the studies completed within this project may lead to a transformation into utilizing scales to evaluate the behavioral determinants which are most important to an individual or group of individuals. The most important behavioral determinant could then be targeted within a customized implementation strategy. For example, if an individual identified the perceived benefits of ERIPPs was the most important behavioral determinant of ERIPP participation, an intervention consisting of the benefits of participating in an ERIPP and data to support the information would be presented to the individual. This shift to client-specific intervention strategies may lead to an increase in ERIPP compliance. An increase in compliance may transfer to a reduction in lower extremity injuries within physically active adults. Preventing these injuries from occurring will allow individuals to avoid the short-term and long-term negative consequences. Additionally, there will be a reduction in the amount of resources needed to treat and rehabilitate musculoskeletal injuries within the healthcare system.

Operational Definitions

Physically Active: Participating in a minimum of 90 minutes of moderate level physical activity per week

Exercise Related Injury Prevention Program (ERIPP): Neuromuscular based training containing balance, range of motion, agility, and strengthening exercises aimed at preventing musculoskeletal injuries that occur due to participation in physical activity

Compliance: The frequency of participation in an ERIPP based on the recommended frequency of exercise participation

Intention: Purpose or attitude toward participating in an ERIPP

Collegiate Athlete: An individual who participates in a sport that is funded and organized by the institution. Sports must be sanctioned by the National Collegiate Athletic Association.

Club sport Athlete: An individual who participates in a sport that is an organized club sport at the institution.

Recreational Athlete: An individual who participates in organized or unorganized sports or exercise activities for recreational purposes.

Assumptions

For Chapter III

1. Subjects were physically active.
2. Subjects were honest and accurate when reporting information on all questionnaires and scales.
3. Subjects clearly understood the content of the questionnaires and scales.

For Chapter IV

1. Subjects were physically active
2. Subjects honestly reported their attitudes towards exercise related injury prevention programs utilizing the scales provided
3. Subjects clearly understood the content of the scales provided

For Chapter V

1. Subjects were physically active

2. Subjects honestly reported their attitudes towards exercise-related injury prevention programs utilizing the scales provided
3. Subjects clearly understood the content of the scales provided
4. Subjects put forth maximal effort while participating in the Y-Balance Test and Landing Error Scoring System

Limitations

For Chapter III

1. Subjects self-reported attitudes towards ERIPP participation
2. The scales utilized had not been previously validated
3. The study sample consisted only of physically active individuals on Old Dominion University's campus

For Chapter IV

1. Subjects self-reported attitudes towards ERIPP participation
2. The study sample consisted only of physically active individuals on Old Dominion University and Virginia Wesleyan College's campuses

For Chapter V

1. Subjects self-reported attitudes towards ERIPP participation
2. Compliance was limited by attendance to club sport practice
3. The study sample consisted only of club sport athletes on Old Dominion University's campus
4. Occurrence of lower extremity injury was not tracked throughout the duration of the study

Delimitations

For Chapter III

1. Subjects were physically active adults between the ages of 18-35

For Chapter IV

1. Subjects were physically active adults between the ages of 18-35

For Chapter V

1. Subjects were club sport participants at Old Dominion University between the ages of 18-35 who participated in men's and women's rugby and women's volleyball

CHAPTER II

REVIEW OF THE LITERATURE

The purpose of this chapter was to review the literature regarding 1) the social or behavioral theories used within exercise-related injury prevention program (ERIPP) research 2) the level of use of the social or behavioral theory within ERIPP research 3) the application of the Health Belief Model (HBM) and Theory of Planned Behavior (TPB) within ERIPP research. Project IA systematically reviewed the literature related to social or behavioral theory use within ERIPP research. Project IB evaluated two social or behavioral theories, HBM and TPB, and their potential application to ERIPP research. Overall, this chapter provides a synthesis of the literature surrounding the use of social or behavioral theories within ERIPP research and how those theories could be applied to ERIPP research.

PROJECT 1A: THE USE OF THEORETICAL MODELS WITHIN EXERCISE-RELATED INJURY PREVENTION PROGRAM RESEARCH: A SYSTEMATIC REVIEW

Introduction

Musculoskeletal injuries to the lower extremity are common among those who participate in physical activity.[1,21] These injuries have several short-term consequences such as functional limitations, time loss from participation in occupational and recreational activity, and economic burden.[6,7] In addition to the immediate ramifications of lower extremity musculoskeletal injuries, there are also long-term consequences such as a decreased health-related quality of life and early development of osteoarthritis which can affect people over their lifespan.[4,5] Due to the negative impact of lower extremity musculoskeletal injuries, an increased emphasis has been placed on the prevention of these injuries.

Exercise-related injury prevention programs (ERIPPs) have been developed to prevent the occurrence of lower extremity musculoskeletal injuries in physically active populations. These programs often include components to improve strength, range of motion, balance, and agility specifically to address contributing factors associated with lower extremity musculoskeletal injuries. Fortunately, multiple studies have concluded that ERIPPs can effectively reduce the incidence of lower extremity injuries.[10] However, one of the barriers which influences ERIPP effectiveness is compliance of the user to complete the recommended exercises.[11] The reasons for poor ERIPP compliance are not well understood; however, overcoming this barrier is critical to achieving a greater reduction in injury risk for those participating in physical activity.

Incorporating behavioral and social science theories and models into ERIPP research may expand the underlying issues associated with poor compliance from the user's perspective. These theories and models provide a systematic way to better understand the reasons for lack of uptake which may lead to the development of appropriate implementation strategies.[22] Behavioral and social science theories have been utilized to better understand participation in other preventative health behaviors such as vaccine uptake, mammography screenings, and bicycle helmet use.[13-15] There is a possibility that the same theoretical models can be applied within ERIPP research to transform ERIPP delivery and improve compliance.

A systematic review published in 2010 examined the use of theoretical models within sport-related injury prevention research.[16] The search identified 100 articles related to injury prevention in sport. A majority of the identified articles were related to protective equipment, while only a few focused on ERIPPs.[16] More importantly, only 11 of the 100 identified articles specified using a social or behavioral theoretical model within injury prevention research related to sport. Most of these studies aligned with the use of protective equipment to prevent injuries from occurring during participation in sport.[16] Only four studies tested the ability of a social or behavioral theoretical model to better explain the phenomenon. Most studies used theory to provide insight for program design.[16] Within the studies that focused on neuromuscular based exercises, none used social or behavioral theories in any capacity. The Theory of Planned Behavior, Health Belief Model, and Self-Efficacy Theory emerged as the theories which were actually tested within the studies.[16] ERIPP research has been more prominent since the publication of the aforementioned systematic review and there is a possibility that the inclusion of theoretical models within ERIPP research has expanded. There is a need to determine which theoretical models are most prominently incorporated within this area of research to make

additional progress in the field. Therefore, the purposes of this systematic review were to determine which behavioral or social sciences theories have been most prominently incorporated within ERIPP research and discover the capacity in which theories were used within ERIPP research (scale design, testing theoretical construct, etc) within the time period of 2010 to 2017.

Methods

A systematic search was completed using the following databases: Academic Search Complete, CINAHL, Psychology and Behavioral Sciences Collection, SportDiscus, and PubMed. The search was limited to July 2010-November 2017, human subjects, and English language. The keywords included were 'theoretical model', 'theoretical framework', 'theory of planned behavior', 'health belief model', 'prevent*', 'prophylactic', and 'sport'. The Theory of Planned behavior and Health Belief Model were included within the search terms because they were frequently referenced and tested within research related to injury prevention in sport.[16] The summary of the search strategy, number of papers identified, and number of papers excluded at each stage are included in Figure II.IA.1. After the initial search was completed, all duplicate studies were removed. Studies were then excluded based on title and abstract. The remaining studies were reviewed by full text to determine inclusion.

The following inclusion criteria was used to screen studies for inclusion in the systematic review: 1) Published in a peer-reviewed journal 2) Measured a behavioral component (attitude, perception, etc.) related to ERIPP participation, 3) ERIPP focused on balance, strength, range of motion, or agility exercises with the goal to prevent lower extremity musculoskeletal injury in sport, 4) Used a behavioral or social science theory or model to guide program design, assess perceptions, or assess changes in perceptions. The following exclusion criteria was used: 1)

Published abstracts or conference proceedings 2) the article was written in a language other than English 3) the study was performed on animals 4) the article was published prior to July 2010.

Once the final articles were retained, they were reviewed and the theoretical model used within each study was identified. Additionally, the use of the theoretical model was classified according to categories transformed from McGlashan et al[16] and Trifiletti et al.[23] The categories and a brief description can be found within Table II.IA.1. The categories represent increasing levels of theoretical application starting with theory for program design and progressing to testing a theoretical construct.

A custom critical appraisal tool was created to effectively evaluate the study design and methodology within the included studies. The construction of the tool was based on a previously utilized critical appraisal tool[24] and a critical appraisal tool designed to evaluate pre-post study designs.[25] The tool consisted of 14 items which can be found in Table II.IA.2. The evaluator assigned yes, no, or not applicable to each item. Two raters independently critically appraised each article. The raters met to discuss the critical appraisal tool for each study and disagreements were resolved through discussion. Total scores (0-14) were calculated out of the total number of applicable items and then converted to percentages. Therefore, items that were not applicable to the study in consideration were not included. A “yes” response to an individual item was assigned 1 point while a “no” answer was assigned 0 points. Therefore, greater scores were indicative of higher quality studies. The studies were then dichotomized into limited quality (<60%) and higher quality (≥60%).

Results

The systematic search identified seven articles that explored the use of theoretical models to better understand the use of ERIPPs and were included into the systematic review. The

characteristics of the article, theoretical model, level in which the theoretical model was implemented, and critical appraisal score can be found in Table II.1A.3. Four studies[26-29] evaluated perceptions and attitudes within athletes, while three studies[20,30,31] investigated the attitudes and perceptions of coaches. Five studies[26-29,31] were cross-sectional, one study[20] utilized a pre-post study design and evaluated the behavioral determinants before and after an intervention, and one study[30] evaluated the behavioral determinants after an intervention was introduced.

The studies included within this systematic review used quantitative and qualitative approaches to assess behavioral determinants of ERIPP participation. All studies utilized a survey to assess behavioral determinants. Some surveys were directly based on a theoretical model while others were indirectly related to a theoretical model.

Theories

Four different behavioral and social theoretical models or frameworks were used within the included articles. One study[26] utilized the Self-Determination Theory (SDT), three studies[27,28,31] used the Health Belief Model (HBM), two studies used the Theory of Planned Behavior (TPB),[20,29] and two studies[30,31] incorporated the RE-AIM framework.

Level of Theory Implementation

Two studies utilized theory at the C level[26,29] meaning the theoretical model or framework was tested. One study tested the SDT related to ERIPP participation.[26] One additional study assessed the ability of the constructs of the TPB to inform intention to participate in an ERIPP.[29] Five studies[20,27,28,30,31] were categorized as Category B meaning the level of implementation involved measuring theoretical constructs related to ERIPP participation. One of these studies measured the theoretical constructs before and after the implementation of an

intervention aimed at improving behavioral determinants of ERIPP participation.[20] The other studies only measured the theoretical constructs on one occasion.[27,28,30,31] None of the included studies were identified within Category A meaning the theory was used exclusively for program design.

Athlete's Perceptions

Four studies[26-29] assessed the perceptions of athletes towards ERIPP participation. One of the studies compared perceptions of ERIPP participation between those who had participated in an ERIPP and those who had not.[27] Those who participated in the ERIPP found the ERIPP to be more beneficial, less challenging, and more enjoyable than those who had not participated in the ERIPP. Overall, the perceptions of athletes towards ERIPP participation were positive. Most participants believed participating in an ERIPP would decrease the risk of lower extremity injury.

Coaches' Perceptions

Three studies[20,30,31] assessed the perceptions of coaches towards ERIPP participation. One study indicated that coaches, fitness coaches, and physiotherapists acknowledged there was a risk for lower extremity injury and athletes should participate in an ERIPP.[31] One of the studies assessed changes in attitudes and implementation rates of coaches following an intervention.[20] One study evaluated attitudes towards ERIPPs after the coaches implemented an ERIPP.[30] Most coaches observed improvements in both athletic performance and reduced risk of injury. One important perspective found within this study was coaches believed their training to become a coach did not prepare them to effectively implement an ERIPP.

Interventions

One of the studies included within this systematic review assessed perceptions of ERIPPs before and after the implementation of an intervention. An intervention was utilized to improve coaches' perceptions of ERIPP use.[20] The intervention consisted of information regarding the negative impact of lower extremity injury, importance of proper landing technique and movements, and evidence of the effectiveness of ERIPPs to prevent lower extremity injury. The coaches were also instructed how to implement the ERIPP. The intervention effectively improved coaches' attitudes towards implementing an ERIPP, confidence in implementing an ERIPP, and intention to implement an ERIPP in the upcoming season. However, only 53% of coaches implemented the ERIPP.

Critical Appraisal

The mean percentage critical appraisal score was 74%. Only one study fell into the limited quality category with a 55%.[30] The remaining six studies were classified as high quality with a 73%,[28,31] 75%,[27] 79%,[20] and 82%.[26,29] None of the studies provided justification for sample size. Five studies utilized scales to measure behavioral determinants of ERIPP participation in which the psychometric properties had not been previously established.[20,27,28,30,31] Five studies did not clearly describe the characteristics of the participants used within the study. [20,27,29-31] One article did not describe the sampling method[26] while another utilized a scale to measure behavioral determinants of ERIPP participation that was not grounded in theory.[30]

Discussion

A previous systematic review published in 2010 indicated that none of the articles related to ERIPPs included social or behavioral theoretical models or frameworks in any capacity.[16] The most notable findings of the current systematic review were that a number of studies since 2010

have incorporated some form of behavioral or social science theory. The HBM and TPB were the two most common theoretical models utilized within ERIPP research and the level of use has greatly improved from mostly level A to mostly level B. Therefore, the use of theory has expanded from simply guiding program design to assessing specific constructs of the theories. The current systematic review identified 7 articles which utilized theoretical models. None of the 7 articles exclusively used the theoretical model for program design. Five[20,27,28,30,31] of the included articles measured a specific theoretical construct and two[26,29] of the articles tested the application of the theoretical model. These results indicate that the incorporation of theoretical influence within ERIPP participation research is increasing. However, there is still limited use of behavioral or social theoretical model use. The use of theory is pertinent in gaining a better understanding of the barriers to ERIPP implementation. The information gained can then be used to inform the development of intervention strategies to improve ERIPP implementation and compliance.

The two most commonly identified theoretical models were the HBM and TPB. The HBM is commonly used to predict and better understand participation in a health behavior.[17] The HBM consists of six constructs which are directly related to participation: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy. Perceived susceptibility refers to the individual's beliefs regarding the chance of sustaining an injury while perceived severity refers to the individual's beliefs regarding the potential consequences of sustaining an injury. Perceived benefits represents any advantages the individual perceives with participating in an ERIPP while perceived barriers represents any obstacles the individual perceives in participating in an ERIPP. Cues to action are any form of reminder either internal or external that may cause the individual to consider participating in an

ERIPP. The individual's perceptions related to confidence in participating in an ERIPP is referred to as self-efficacy. The HBM uses 6 constructs to predict participation in a preventative health behavior.

The TPB is used to better understand and predict participation in health behaviors.[18] The model contains three constructs which are indirectly related to participation in the health behavior through intention to participate. The three constructs are attitudes, perceived social norms, and perceived behavioral control. Attitudes refers to the individual's perceptions regarding whether the ERIPP is beneficial and enjoyable. Perceived social norms is defined by attitudes towards ERIPPs of important individuals within the life of the user. The confidence an individual has in participating in an ERIPP is defined as perceived behavioral control. The TPB uses 3 constructs to predict intention to participate in a preventative health behavior.

The systematic review also identified that theoretical models have been utilized for several different purposes related to ERIPP participation. Several studies utilized theoretical models to assess behavioral determinants of ERIPP participation within athletes, while others assessed behavioral determinants of ERIPP implementation within coaches. Athletes and coaches generally had positive attitudes towards ERIPP participation. Additionally, they believed the largest benefits of participating in an ERIPP would be improvements in athletic performance and a reduced risk of lower extremity musculoskeletal injury. The effectiveness of ERIPPs to reduce the risk of lower extremity musculoskeletal injuries is highly supported by many systematic reviews.[10,32,33] However, the ability of an ERIPP to improve athletic performance is lacking research support.

One study included within the systematic review utilized a theoretical model to assess behavioral determinants of ERIPPs within athletes and compare the behavioral determinants

between those who had participated in an ERIPP and those who had not.[27] The individuals who had participated in an ERIPP found the ERIPP to be more beneficial, less challenging, and more enjoyable than those who had not participated in an ERIPP. The results of this study indicate that previous use of an ERIPP may influence behavioral determinants of ERIPP participation. Therefore, intervention strategies aimed at improving behavioral determinants of ERIPP participation and compliance of ERIPPs may need to be customized to meet the needs of individuals who have participated in an ERIPP before and those who had not.

The final purpose of utilizing a theoretical model within ERIPP research was to determine if an intervention was effective at improving behavioral determinants and compliance with an ERIPP. An intervention was focused towards improving the behavioral determinants of soccer coaches and increase implementation of an ERIPP known as the 11+.[20] The intervention improved coaches' attitudes and perceptions of ERIPP participation. However, only 53% of the coaches implemented the ERIPP. Therefore, further investigation is needed to determine if there is a more effective intervention which will lead to improvements in attitudes along with adoption and compliance rates. Coaches are instrumental in the implementation of ERIPPs within the team setting. The results of this study indicate that further research needs to be done to investigate interventions targeted for coaches to improve implementation of ERIPPs.

The critical appraisal of the articles included within this systematic review revealed a few key factors. Many of the articles included within the study failed to appropriately describe the characteristics of the participants included in the study.[20,27,29-31] Prior to developing effective intervention strategies to improve compliance, we must better understand the perceptions and attitudes of the users and coaches towards ERIPP participation and implementation. There are specific demographic variables that may influence those perceptions such as previous experience

coaching, previous number of years playing a sport, age, etc. When these variables are not clearly defined within the participants' demographics of studies, our understanding of these variables is limited. Additionally over half of the articles utilized scales to assess behavioral determinants of ERIPP participation that did not have previously established psychometric properties.[20,27,28,30,31] In order for clinicians and researchers to effectively utilize these scales to assess attitudes and perceptions of ERIPP participation, we must be sure the scales are assessing the intended behavioral determinants of ERIPP participation. Scales grounded within behavioral and social theoretical models and frameworks should be established to assess behavioral determinants of ERIPP participation. The psychometric properties of the scales including construct validity and internal consistency should be established within a physically active population to begin utilizing them within research and clinical practice.

Limitations

There were several limitations associated with this systematic review. There is a potential that additional articles could be in the published literature that were not identified in the search. Some studies may have used behavioral or social theoretical models or frameworks, but it was not evident within the article. The definition used for ERIPPs could have excluded some pertinent articles. However, the intent of the systematic review was to investigate the use of theory within research related to specific types of sports injury prevention. Therefore, future systematic reviews should investigate the use of theory within literature investigating other types of injury prevention related to sport such as protective equipment. Additionally, the search limited the articles to the English language. ERIPP use is prevalent in many other countries and there is a chance some articles may have been missed due to the language.

Implications for Future Research

The current systematic review has indicated that there has been an increase in the use of theoretical models within ERIPP research. However, there is still a lack of inclusion of behavioral and social theoretical model use. Overall, there was an improvement from using theory at a level for program design to assessing constructs within the theoretical model. One key factor identified within this systematic review was a lack of surveys grounded in theory to assess behavioral determinants of ERIPP participation in which the psychometric properties had been established. The first step in moving forward is to develop scales grounded in social or behavioral theories to assess the behavioral determinants of ERIPP participation. Additionally, the psychometric properties of the scales should be established within a physically active population. Once these scales are widely used to assess the behavioral determinants of ERIPP participation within different populations with varying previous experiences and demographic variables, the results can be used to inform the development of implementation strategies.

Key Messages

What is already known?

- There is a lack of use of behavioral and social theoretical model use within research related to injury prevention within sport.
- The main use of theory within injury prevention literature related to sport has been for program design.
- Injury prevention literature specific to exercise-related injury prevention program use has not included theoretical models.

What this study adds

- There has been an improvement in the use of behavioral and social theoretical model use within literature that is specific to exercise-related injury prevention program use.

- The two most commonly used theoretical models were the theory of planned behavior and health belief model.
- The use of theory has expanded beyond program design to measuring specific theoretical constructs and testing the theories.

Table II.IA.1. Categorical Classification of the Use of Theory

Category	Description
A	The health behavior theory was used for program design and/or implementation, and/or select program measures
B	Measurement of a theory or construct or model was undertaken (data was provided that described predisposing or enabling factors of player safety practices)
C	A theoretical construct or an extension of a theory was tested (whether the theory of planned behavior was helpful in understanding variations in attitudes)
Other	The use of the behavioral theory did not conform to any of the categories mentioned above

Table II.IA.2. Critical Appraisal Tool

Question
1. Are the research objectives clearly stated?
2. Is the study design clearly described?
3. Were participant characteristics clearly described?
4. Was sampling methodology appropriately described?
5. Was sample size used justified?
6. Were the psychometric properties of the scale used previously established?
7. Was the scale used directly related to a behavioral or social theoretical model or framework?
8. Was the intervention clearly defined?
9. Were appropriate statistical methods used?
10. Was the loss to follow-up after baseline 20% or less? Were those lost to follow-up accounted for in analysis?
11. Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided p values for the pre-to-post changes?
12. Were the main outcomes of the study clearly stated?
13. Were key findings supported by the results?
14. Were limitations of the study clearly described?

Table II.IA.3. Study Details

Author and Design	Theory Used	Subject Characteristics	Measurement Tool	Methods	Main Results	Theory Use	Critical Appraisal Score
Chan & Hagger Cross-sectional	SDT	533 elite athletes (international, national, or regional level athletes from 13 sports	Adapted version of Health Care Climate Questionnaire, Basic Need Satisfaction in Sport Scale, Behavioral Regulation in Sport Questionnaire, Treatment Self-Regulation Questionnaire, Self-Reported Adherence of Sport Injury Prevention, adapted Manager Safety Attitude Questionnaire, General Causality Orientation Scale	The first set of scales were administered to the participants. One week later, the second set of scales were administered.	Three paths were identified. Perceived autonomy support informed basic need satisfaction which informed self-determined motivation in sport which informed self-determined motivation for sport injury prevention. Self-determined motivation for sport injury prevention had significant positive associations with adherence, safety commitment, and injury priority and significant negative associations with fatalism concerning injury prevention, attitude toward safety violation, barriers to safety communication, and injury worry.	C	9/11 82%
Finch et al. (2011) Cross-sectional	HBM	374 male football players aged 17-38	Questionnaire modeled on previous studies of risk and safety attitudes which broadly drew on HBM components; demographic questionnaire	Participants completed questionnaires aimed to assess their attitudes towards injury prevention programs one time during a training session	74.4% of participants agreed IPPs would decrease their risk of injury and would be willing to participate in them; 64.1% agreed that training should be focused on improving athletic performance rather than injury prevention; Younger players had more positive beliefs towards IPPs;	B	8/11 73%

Table. II.IA.3. Continued

Author and Design	Theory Used	Subject Characteristics	Measurement Tool	Methods	Main Results	Theory Use	Critical Appraisal Score
Finch et al. (2013) Cross-sectional	HBM	Male football players who had participated in a cluster randomized controlled trial including an IPP as one of the treatments	Post-season self-report survey derived from the HBM containing both open ended and Likert scale questions.	Participants of a cluster randomized controlled trial which included one control group and one group who participated in an injury prevention program completed questionnaires at the end of the season.	Those who participated in the IPP found it to be less challenging, more enjoyable, and beneficial than those who did not participate in the IPP; Players suggested the IPP be shorter in duration, have a larger range of exercises, and for the benefits of the IPP to be explained to the participants.	B	9/12 75%
Frank et al. Pre-post study	TPB	34 soccer club coaches	Questionnaire to assess attitudes related to injury prevention programs based on the theory of planned behavior	Attitudes towards injury prevention programs were evaluated before and after a coaching workshop. At the end of the season, compliance of the coaches to implement the program was measured.	After the workshop, coaches' attitudes towards injury prevention programs, thoughts about substituting an injury prevention program for a warm-up, and beliefs about improving player's cutting and landing techniques by implementing an injury prevention program were more positive. The coaches' intent to implement the injury prevention program also improved. However, only 53% of coaches implemented the injury prevention program.	B	11/14 79%

Table.II.IA.3. Continued

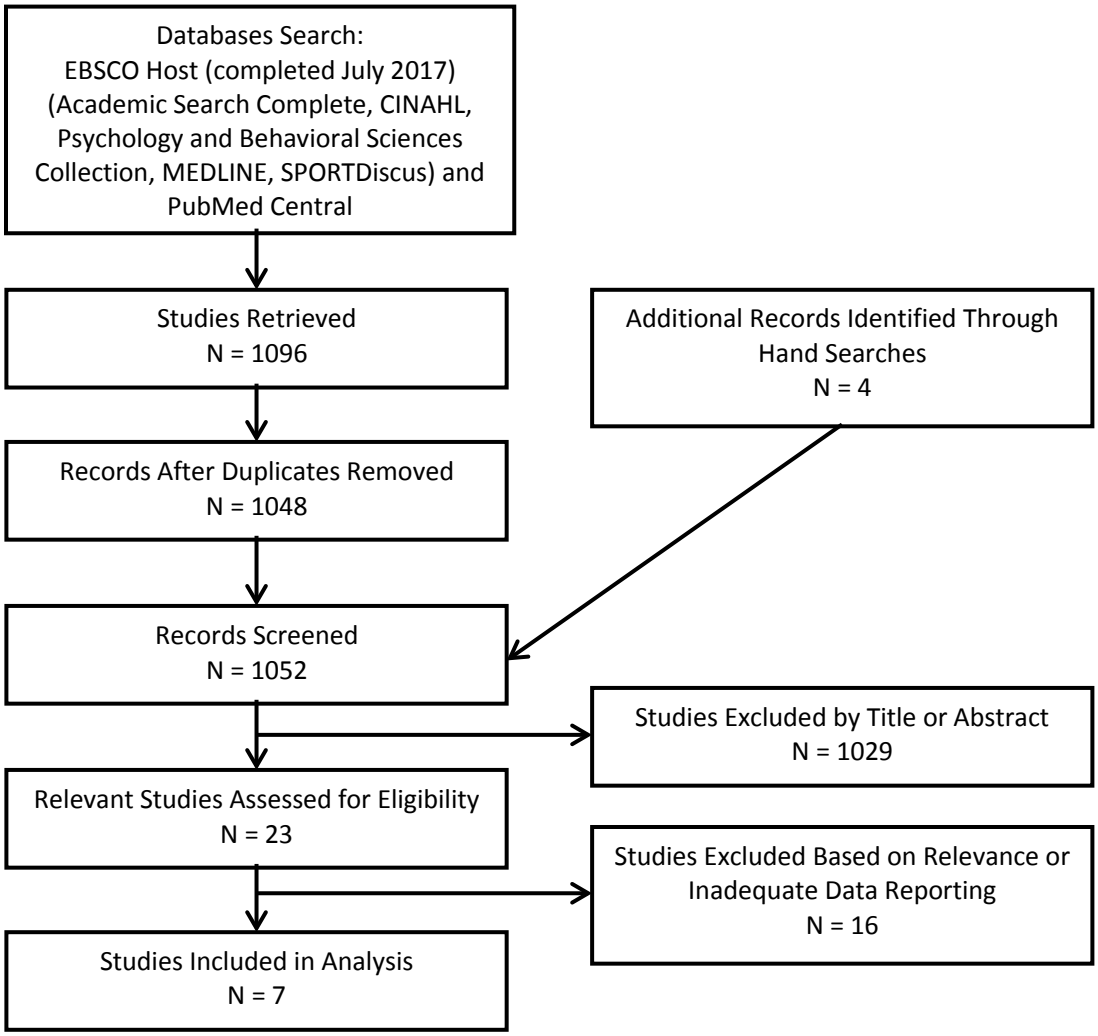
Author and Design	Theory Used	Subject Characteristics	Measurement Tool	Methods	Main Results	Theory Use	Critical Appraisal Score
O'Brien & Finch (2016) Cross-sectional	HBM/REAIM	18 soccer coaches, fitness coaches and physiotherapists working with elite male soccer teams.	Survey guided by the REAIM and HBM to assess attitudes towards the 11+ injury prevention program. Open questions were included to assess barriers and facilitators of implementing the 11+.	Coaches, fitness coaches and physiotherapists associated with 4 elite soccer teams were asked to participate in an online survey. The survey was disseminated using Survey Monkey and the participants completed the survey on one occasion.	Participants agreed players were highly susceptible to lower extremity injuries and that the injuries were serious. All respondents agreed that athletes should participate in injury prevention programs. The main barriers identified within implementing the 11+ related to program content or delivery and support of the program.	B	8/11 73%
Saunders et al. (2010) Post-only	RE-AIM	24 netball coaches who implemented the D2E injury prevention program	Questionnaire assessing perceived advantages, disadvantages, barriers, and facilitators regarding the D2E injury prevention program.	Coaches attended a 1-hour educational session which included information about the D2E injury prevention program, anticipated barriers and ways to overcome them. Coaches completed a survey assessing their perceptions of the D2E injury prevention program 17 weeks after the intervention.	Advantages included improvement in athletic performance, improvement in landing technique, and a reduction in injury risk. The most commonly identified barriers were running out of time and the younger athletes finding the exercises too difficult. Coaches reported their coaching training didn't prepare them to implement an injury prevention program.	B	6/11 55%

Table.II.IA.3. Continued

Author and Design	Theory Used	Subject Characteristics	Measurement Tool	Methods	Main Results	Theory Use	Critical Appraisal Score
White et al. (2012) Cross-sectional	TPB	287 female netball players	Questionnaire designed using the TPB to assess attitudes towards learning correct landing technique	Participants completed a baseline questionnaire on their attitudes and perceptions of learning proper landing technique prior to their coaches implementing the D2E injury prevention program.	Participants had positive attitudes towards learning correct landing technique, perceived positive social pressure from significant others to learn correct landing technique, and perceived that they themselves had considerable control over whether they leaned correct landing technique. Participants also had positive intentions to learn correct landing technique with 73.6% stating a strong intention. Significant associations were found for subjective norms and attitudes to intent to learn correct landing technique.	C	9/11 82%

SDT=Self Determination Theory
HBM=Health Belief Model
TPB=Theory of Planned Behavior
RE-AIM=Reach, Effectiveness, Adoption, Implementation, Maintenance

Figure II.IA.1. Results of Search



PROJECT 1B: HEALTH BELIEF MODEL AND THEORY OF PLANNED BEHAVIOR: A THEORETICAL APPROACH FOR ENHANCING LOWER EXTREMITY INJURY PREVENTION PROGRAM PARTICIPATION

Introduction

Lower extremity injuries are common among the physically active population.[1] Over 50% of all injuries in collegiate athletes that occur in practices or games involve the lower extremity.[1] Among lower extremity injuries, ankle sprains account for approximately 14% and 23% of all collegiate and high school athletic injuries, respectively.[1,3] Individuals who sustain lower extremity injuries are more likely to develop long-term consequences such as osteoarthritis [5,34,35] and a decreased health-related quality of life.[4] Therefore, primary prevention efforts to reduce the incidence of lower extremity injuries through various screening assessments and corresponding interventions are warranted to reduce the healthcare burden of these conditions.

Exercise-related injury prevention programs (ERIPPs) have been established to prevent the occurrence of lower extremity injuries. These programs have demonstrated success in preventing various lower extremity injuries.[10,36] However, one of the limiting factors of ERIPP effectiveness is program compliance.[11] This has been highlighted through a recent meta-analysis which indicated ERIPPs focused on anterior cruciate ligament injury prevention were more effective in studies which documented high compliance rates. The reasons for poor compliance and low implementation rates for ERIPPs are unknown. It can be speculated that many of the barriers (i.e. cost, time, etc.) associated with other health prevention practices likely cross over to ERIPP participation; however, this has not been thoroughly investigated. Utilizing behavioral and social science theories which have been used to examine determinants of other forms of health prevention may elucidate why individuals are failing to participate in ERIPPs.

There is very limited research examining behavioral and social science theories and their ability to predict the ERIPP adoption and compliance.[16] Only 11% of all sport-related injury prevention intervention studies mention the use of a behavioral or social science theory. Within that percentage, only 4 out of 100 studies tested a theory. Most of the studies used theory to guide the ERIPP design or to measure a specific theoretical construct.[16] The lack of utilization of behavioral or social science theory in implementing ERIPPs may contribute to the lack of adoption or low compliance rates of ERIPPs. Incorporating theoretical models may lead to innovative changes in the design and implementation of ERIPPs once more information is gathered regarding the determinants, attitudes, and perceptions of these programs from the involved stakeholders.[37,38]

While there are a number of behavioral and social science theories which could be relevant to ERIPP participation and compliance, the Health Belief Model (HBM) and Theory of Planned Behavior (TPB) are the most commonly used within health related research and have been investigated together to predict participation in other preventative health behaviors.[14,16] The purposes of this paper are to examine the current use of the HBM and TPB within ERIPP research, introduce an integration of the two theories, and identify possible ways to include these theories in research and clinical practice.

Health Belief Model

The HBM contains factors that are thought to directly predict participation in a health behavior (Table II.IB.I).[17] The HBM constructs are categorized by two main aspects which are threat perception and behavioral evaluation. Within the threat perception aspect, perceived susceptibility and perceived severity are considered. Behavioral evaluation encompasses the

potential benefits and barriers of adopting the health behavior. As the theory developed over time, cues to action and self-efficacy were added.[17]

Threat perception encompasses two main constructs which are perceived susceptibility and perceived severity.[17] *Perceived susceptibility* is the individual's perception of the likelihood of sustaining a lower extremity injury. The individual's beliefs can range anywhere from a complete denial of the possibility of sustaining an injury to perceiving there is an eminent danger of sustaining an injury while participating in physical activity.[39] *Perceived severity* is defined as the individual's beliefs regarding the seriousness of the consequences of sustaining an injury.[17] Some of the potential consequences associated with these injuries are pain and discomfort, time loss from work or sport, financial burdens, difficulty completing family oriented tasks, and potential long-term consequences.[39] An individual could be highly aware of the potential consequences of a lower extremity injury or may not even realize that there is a possibility of sustaining an injury severe enough to experience consequences.

Behavioral evaluation describes the two constructs associated with benefits and barriers of participating in a particular health behavior. *Perceived benefits* are the individual's beliefs about the advantages of participating in an ERIPP.[17] Some individuals may see very little benefit while others may see an important benefit. Benefits may include injury prevention, increased strength, and improved knowledge regarding lower extremity injuries and injury prevention**.** *Perceived barriers* are described as the potential obstacles that may prevent an individual from engaging in an ERIPP. Some potential barriers may be inconvenience, expense, and pain or discomfort.[39]

Cues to action and self-efficacy are two additional constructs that were added to the HBM. *Cues to action* are potential cues an individual may encounter that encourage them to

participate in a health behavior.[40] These could be internal cues which include the individual realizing the level of susceptibility and potential severity of an injury or external cues which include a physician, athletic trainer, coach, or teammate encouraging the individual to participate in an ERIPP.[39] *Self-efficacy* is the individual's beliefs of whether they are capable of participating in an ERIPP. If an individual has previously participated in an ERIPP, they may be more confident in their ability to participate in a future ERIPP. However, if the individual has not participated in an ERIPP, they may be less confident in participating in the program.

Theory of Planned Behavior

The TPB contains three components that are thought to indirectly predict participation in a health behavior through intention to participate (Table II.IB.2).[18] Based on this theory, intention is the strongest predictor of whether an individual will participate in a health behavior. The three constructs within the TPB are attitude, subjective norm, and perceived behavioral control. *Attitude* is described as the overall evaluation of the health behavior.[41] A few examples are whether the individual views ERIPPs as being fun, boring, beneficial, costly, or convenient. *Subjective norm* is the individual's beliefs about what others think about the behavior. This construct contains the perceived social pressure of the individual to engage in the ERIPP and the beliefs of the social support network of the individual. The network may include immediate family, friends, coaches, and teammates. Lastly, *perceived behavioral control* is the individual's beliefs about their ability to engage in an ERIPP despite the barriers they may face. For example, an individual may have less confidence in their ability to participate in an ERIPP if they do not have access to a program.

Current Literature

Past researchers have investigated the behavioral determinants of ERIPP participation within physically active populations.[31,42] Professional soccer players reported that they were at risk for lower extremity injuries which could have a negative impact on their life and long term career goals and felt they should participate in an ERIPP.[31] Therefore, it appears perceived susceptibility and seriousness may be constructs driving ERIPP participation within professional soccer players. Additionally, female high school athletes indicated they would be more likely to participate in an ERIPP if it could reduce the risk factors associated with lower extremity injuries and reduce the risk of sustaining an anterior cruciate ligament tear. [42] The perceived benefits of the ERIPP were most important to this population when determining whether they would participate in an ERIPP. Therefore, the behavioral determinants of ERIPP participation may be contextually dependent the characteristics of various physically active populations.

Two studies have investigated the use of an educational intervention to improve behavioral determinants and participation within an ERIPP. An educational workshop focused on education regarding ERIPPs and possible strategies to enhance implementation was utilized within coaches. The intervention was able to improve knowledge and attitudes towards ERIPPs within sports coaches.[20] However, only 53% of the coaches implemented the ERIPP within their team.[20] Therefore, it is necessary to continue exploring interventions to improve coach's implementation while also increasing participation in end users. In a separate study, an educational intervention focused on anterior cruciate ligament (ACL) function, risk factors for ACL injury, and reduction of risk techniques which was coupled with demonstrations of proper landing techniques and preventative exercises for high school basketball players. This intervention was able to improve knowledge and attitudes towards ERIPPs;.[19] however, the

participation rates did not improve. These studies indicate the intervention may need to be enhanced beyond education alone to shift from improving attitudes to improving participation in ERIPPs.

An Integrated Model to Better Understand ERIPP Participation

There is a potential that integrating the HBM and TPB will present a resourceful model for better understanding ERIPP participation.[37,38] Combining the constructs from both theories may provide the most insight into whether an individual will participate in an ERIPP. The integration of these theories has been investigated in preventative health behaviors such as the uptake of human papillomavirus vaccine,[14] but not related to ERIPP participation.

Participating in a vaccine uptake that requires multiple visits may require similar behaviors as participating in an ERIPP over time. The results of this study suggested subjective norms from the TPB and perceived severity, perceived susceptibility, and self-efficacy from the HBM were the best predictors of vaccine uptake [14]. Subjective norm from the TPB represents the beliefs of influential people on the individual engaging in the health behavior. It is reasonable to think an individual would be more likely to participate in an ERIPP if their teammates, coach, friends, or family were participating in the plan with them or encouraging them to participate. Perceived susceptibility involves the individual's knowledge of the risk of sustaining a lower extremity injury. If an individual fully understands the potential risk of sustaining an injury while participating in physical activity, they will be more likely to participate in an ERIPP. Perceived severity describes the individual's beliefs regarding the possible severity of the injury they could sustain and the related consequences. An individual will be more likely to participate in an ERIPP if they realize the short-term consequences such as pain, inability to participate in physical and social activities, and time loss from work or school. Additionally, an individual may

be more likely to participate in an ERIPP if they acknowledge the long-term consequences associated with lower extremity injuries such as osteoarthritis and a decreased health related quality of life. Lastly, self-efficacy regarding the individual's ability to complete an ERIPP may play a role in whether the individual participates in an ERIPP. The individual may be less likely to participate in an ERIPP if they are unsure how to perform the exercises, have time constraints for complete the exercises, or financial concerns with purchasing the equipment necessary to perform the ERIPP.

A hypothetical integrated model has been created to better understand individual level factors associated with ERIPP participation (Figure II.IB.1). The combined model utilizes all of the constructs from the HBM and TPB in which four constructs (TPB: attitudes, subject norm, perceived behavior control; HBM: cues to action) are identified to directly predict intention to participate in an ERIPP and are influenced by the additional constructs (HBM: perceived susceptibility, perceived severity, perceived barriers, perceived benefits, self-efficacy). Finally, all constructs of this model will be influenced by participation in an ERIPP.

The first construct to directly predict intention is attitudes from the TPB. Attitudes will receive input from four constructs of the HBM: perceived susceptibility, perceived severity, perceived benefits, and perceived barriers. The information from these constructs will form the overall attitude of the individual towards lower extremity injury and ERIPP participation. The second construct to directly predict intention is subjective norm from the TPB. The beliefs of important individuals within the social network of a person can be very influential in whether the individual intends to participate in an ERIPP. Some of the main members of the social network for physically active individuals will include teammates, coaches, athletic trainers, family members, friends, and physicians. The third construct to directly predict intention is perceived

behavioral control from the TPB. This construct will receive input from the self-efficacy construct within the HBM. These two constructs together will represent the perceived ability of the individual to participate in an ERIPP despite the barriers they may face. The last construct to directly predict intention to participate in an ERIPP is cues to action from the HBM. Cues to action are cues to participate in a health behavior. Within ERIPP participation, some cues may be a coach, athletic trainer, or physician telling the individual they should participate in an ERIPP. Additional examples could include, a teammate participating in an ERIPP or sustaining a significant lower extremity injury.

The integrated model will form a circular model where participation in ERIPPs will influence the constructs of the HBM and TPB. If an individual participates in an ERIPP, the behavioral determinants related to the ERIPP and lower extremity injury will change. Therefore, if individuals can be convinced to begin an ERIPP, their participation will then influence the behavioral determinants which initially predicted whether they would participate or not. The new integrated model utilizing constructs from both theories may include all aspects that will predict participation in an ERIPP. The new model can be initially tested by determining the correlation between the four main constructs and intention to participate. As more data becomes available, it would be ideal to determine if this model would ultimately predict participation.

Methodological and Analytic Recommendations

The first step to integrate the HBM and TPB into ERIPP research is developing reliable and valid measurement tools to assess the constructs within the theories within the context of ERIPPs. The Champion's Health Belief Model Scale was developed to predict participation in mammography or breast cancer screening.[13] The scale has been adapted to accommodate many different languages and predict participation in other preventative health behaviors.[43-46] The

questions within this scale can be transformed to relate to lower extremity injury and ERIPP participation. For the TPB scale, there are instructions on how to develop a questionnaire by Ajzen.[41] Five to six questions are created for each construct and open ended salient beliefs questions are also utilized to ensure all important content to the target population is included within the scale. The responses to the salient beliefs questions would then be coded and transformed into additional questions within the scale. Both scales assess how strongly an individual agrees or disagrees with statements regarding a health behavior.

The next step in the integration of theoretical models into ERIPP research would be to utilize the scales to assess behavioral determinants and assess the new integrated theoretical model. This would be accomplished by examining the correlation between the four main constructs and the intention to participate in an ERIPP. Additionally, the variance of the four main constructs explained by the constructs providing input can be evaluated. At this time, necessary modifications to the integrated model can be made.

Lastly, intervention plans can be developed based on the theoretical constructs. The most important constructs to the population of interest can be used to construct interventions to improve implementation of the ERIPP. For example, the perceived benefits were the most important construct to female high school athletes.[42] An educational intervention based on the benefits of ERIPP participation could be created. Some of the benefits presented to the participants could be a reduction in lower extremity injury occurrence, an increase in muscular strength and athletic performance, and an increase in knowledge related to injury prevention programs and lower extremity injuries. This process can be completed for any physically active population by administering the HBM and TPB scales to determine the most important constructs followed by developing an intervention based on the findings. These interventions can

be tested for effectiveness using experimental and quasi-experimental study designs. An intervention based on the constructs most important to athletes and coaches may be more effective at improving adoption rates of the program.

Integrating the use of theoretical models into ERIPP research could inform the development of implementation strategies for ERIPPs. The information gained from these studies could shift the implementation strategies currently used to more tailored strategies based on specific demographic variables. Increases in adoption rates and compliance of ERIPPs will lead to a decrease in lower extremity injury occurrence and circumvent the physical and psychological consequences of these conditions.

Clinical Application

The HBM and TPB scales can be utilized to determine beliefs and attitudes associated with ERIPP participation. Clinicians can utilize the scales to determine the areas of intervention with their patients to increase compliance of ERIPPs. For example, if a patient completes the HBM scale and has low scores within the perceived susceptibility construct, an intervention could be developed to educate the individual on the risk of lower extremity injury. Additionally, if the patient reported many barriers to participating in an ERIPP, an intervention could be developed to provide the patient with strategies to overcome those barriers. The scales can be utilized to identify the potential areas of intervention to improve compliance. There is a possibility that some of the attitudes and beliefs towards ERIPP participation may be correlated with demographic variables such as gender or history of lower extremity injury. If this were the case, intervention strategies could be developed specific to certain demographic variables. Further research is necessary to determine if these relationships exist. Additionally, intervention strategies targeting each construct must be tested to determine the effectiveness.

Conclusion

ERIPP compliance plays a role in the effectiveness of reducing the risk of lower extremity injuries amongst physically active individuals. The HBM and TPB may be able to provide insight into the behavioral determinants associated with ERIPP participation. Future research should focus on first developing appropriate instruments to assess the constructs of these theories within physically active populations. Next, the instruments should be utilized to assess the behavioral determinants of ERIPP participation and test the new integrated model of both theories. Lastly, an intervention based on the two theoretical models should be developed and tested for effectiveness. The integration of theoretical models into ERIPP research may allow for a better understanding of the reasons why compliance is low and assist with informing new implementation strategies.

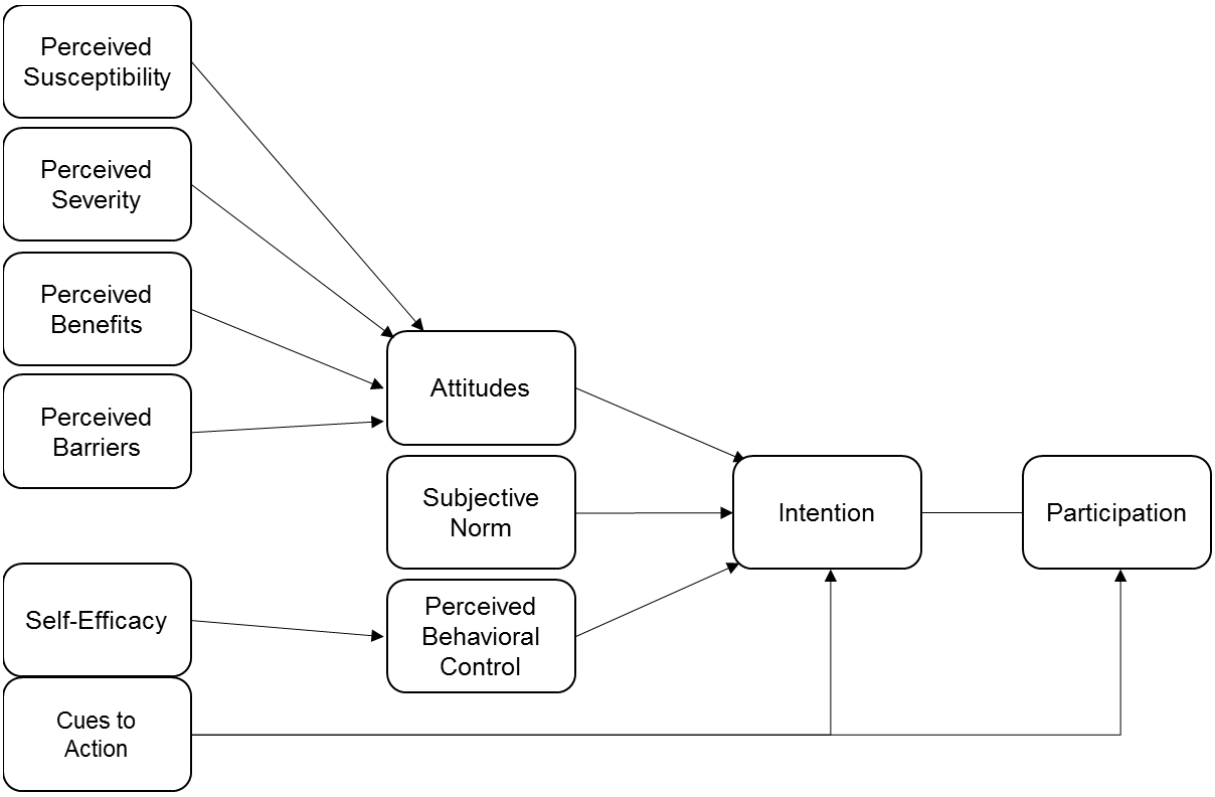
Table II.IB.I. Definitions of Theoretical Constructs of the Health Belief Model

Construct	Definition
Perceived Susceptibility	Individual's perception of the likelihood of sustaining a lower extremity injury[14]
Perceived Severity	Individual's beliefs regarding the seriousness of the consequences of sustaining an injury[14]
Perceived Benefits	Individual's beliefs about the advantages of participating in an ERIPP[14]
Perceived Barriers	Potential obstacles that may prevent an individual from engaging in an ERIPP[14]
Cues to Action	Cues an individual may encounter that encourage them to participate in a health behavior[14]
Self-Efficacy	Individual's beliefs of whether they are capable of participating in an ERIPP[14]

Table II.IB.2. Definitions of Theoretical Constructs of the Theory of Planned Behavior

Construct	Definition
Attitude	Overall evaluation of the health behavior[18]
Perceived Subjective Norm	Individual's beliefs about what others think about the behavior[18]
Perceived Behavioral Control	Individual's beliefs about their ability to engage in an ERIPP despite the barriers they may face[18]
Intention to Participate	Individual's perception of their intention to participate in an ERIP[18]

Figure II.IB.1. Integrated Model of the Health Belief Model and Theory of Planned Behavior to Understand Factors Related to ERIPP Participation



CHAPTER III

PROJECT II: THE DEVELOPMENT OF THE THEORY OF PLANNED BEHAVIOR AND HEALTH BELIEF MODEL SCALES: ASSESSING BEHAVIORAL DETERMINANTS OF EXERCISE-RELATED INJURY PREVENTION PROGRAM PARTICIPATION

Introduction

Lower extremity injuries are common among the physically active population and account for more than 50% of injuries that occur within collegiate and recreational athletes.[1,2,47] Individuals who sustain these injuries may develop long term consequences such as functional impairments, decreased health-related quality of life, and osteoarthritis.[4,5] Exercise-related injury prevention programs (ERIPPs) have been developed to prevent these injuries from occurring. Several studies have found ERIPPs to be effective for reducing lower extremity injuries.[10,32] However, one of the major limitations of ERIPP effectiveness is participant compliance to complete the prescribed exercises.[11]

It is unclear why ERIPP compliance is low within physically active populations. One potential reason why compliance issues aren't fully understood is the lack of the use of theoretical models within research related to ERIPP participation. A systematic review revealed that only 11% of research studies related to ERIPP participation included theoretical models.[16] However, theoretical models have been utilized to better understand participation in other preventative health behaviors such as mammography screenings, vaccine uptake, and bicycle helmet use.[13-15] Applying theoretical models such as the Health Belief Model (HBM) and Theory of Planned Behavior (TPB) may aid in elucidating why compliance of ERIPP participation is low from the end-user's perspective. The HBM and TPB have been used to predict participation in

other preventative health behaviors.[14,15] Utilization of these theoretical models within the scale development for new survey instruments to examine the behavioral determinants of ERIPP participation may provide insight into the underlying reasons for the historically low compliance with these programs.

The HBM contains 6 constructs thought to directly predict participation in a health behavior.[48] The first construct of perceived susceptibility are the individual's beliefs regarding their perceived risk for sustaining a lower extremity injury. The second construct is perceived severity or the individual's beliefs regarding the potential consequences of sustaining a lower extremity injury. The third construct is perceived benefits which describes the individual's perceptions of the benefits they may receive from participating in an ERIPP. The fourth construct is perceived barriers which is defined as the perceived obstacles that may prevent an individual from participating in an ERIPP. The fifth construct is cues to action or reminders for the individual to participate in an ERIPP. The final construct is self-efficacy which describes the individual's beliefs about their ability to participate in an ERIPP. The amalgamation of these constructs is thought to provide an indication of participation in a preventative health behavior.

The TPB contains three constructs which are thought to indirectly predict participation in a health behavior through intention to participate (ITP)[18] The first construct is attitudes which is defined as the individual's overall evaluation of the health behavior. The second construct is subjective norm which is the individual's beliefs about what other important individuals in their lives would think about the health behavior. The final construct is perceived behavioral control which is the individual's beliefs about their ability to participate in the health behavior despite any barriers they may face. The three constructs are thought to predict participation in a preventative health behavior through ITP.

While there are several parallels and differences between the theoretical constructs of the HBM and TPB, both theories have demonstrated usefulness in defining the behavioral determinants regarding participation in various health behaviors in an array of populations.[13-15] Therefore, the TPB and HBM may provide insight into the reasons for low compliance associated with ERIPPs in physically active populations. Information gained on the behavioral determinants of ERIPP participation through the use of scales may be used to tailor a specific intervention to improve adoption and use of ERIPPs. The clinician could utilize a scale to assess the behavioral determinants which were most associated with intention to participate in an ERIPP. Based on this information, clinicians could create interventions which target specific behavioral determinants. For example, White et al.[29] found subjective norms and attitudes were most associated with intention to participate in an ERIPP within female netball players. This information could be used to develop educational interventions that would be delivered to participants in conjunction with the ERIPP. For this situation, attitudes could be addressed by promoting the ERIPP as a sport relevant activity with benefits associated with reduced injury risk and performance enhancement. Additionally, educational interventions could be created to address the attitudes of individuals; such as parents and coaches, who may have an influence in the athlete's decision to participate in an ERIPP. There is a potential that first assessing the behavioral determinants of ERIPP participation utilizing scales and then creating a promotion and implementation plan may lead to improvements in adoption and compliance rates. However, there are no current scales directly created using the HBM and TPB to measure behavioral determinants of ERIPP participation.

The purposes of this study were to design and pilot test the HBM and TPB scales associated with ERIPP participation and examine the validity of the scales. We hypothesized the

HBMS and TPBS would have adequate internal consistencies. Additionally, behavioral determinants of ERIPP participation evaluated through the HBMS and TPBS would be significantly correlated to physical and mental function measured using the Disablement of the Physically Active Scale (DPA) and exercise-self efficacy measured through the Exercise Self-Efficacy Scale (ESES). Additionally, anxiety and depression related to health measured through the Hospital Anxiety and Depression Scale (HADS) would be significantly correlated to the subscales of the HBMS and TPBS. These correlations would aid in establishing validity for the HBMS and TPBS.

Methods

Study Design

The design of this study was a single cross-sectional survey. The scales were developed using the HBM and TPB to better understand perceptions of ERIPPs. Additional previously validated scales (modified DPA[49], HADS[50], and ESES[51]) were used to establish validity for the HBM scale (HBMS) and TPB scale (TPBS). All scales were administered electronically using Qualtrics (LLC, Provo, UT).

Participants

Forty-nine physically active adults volunteered to participate in this study (M/F: 15/34; Age: 22.33±3.04 years; Height: 64.97±9.51cm; Weight: 156.29±27.90kg). All participants were physically active for a minimum of 90 minutes of moderate or vigorous physical activity per week. The classification of physically active was confirmed with a question regarding the level of participation in physical activity within the demographic questionnaire. Participants were also asked to categorize their level of physical activity and the sample included collegiate athletes (n=5), recreational athletes (n=17), individuals who exercise for fitness (n=24), and other (n=3).

Procedure

Participants were recruited by flyers and word of mouth on a large public university during the fall semester of the 2016-2017 academic year. Researchers also attended classes within the exercise science and physical therapy departments to recruit participants. Potential participants emailed the primary investigator if they had interest in participating in the survey. A link to access the surveys was then emailed to the potential participant. The study was approved by the Institutional Review Board and informed consent was granted by following the survey link and answering "yes" to proceed with the survey. Once the survey was initiated, participants completed a demographic questionnaire and the HBMS, TPBS, mDPA[49], HADS[50], and ESES.[51]

Measures

Health Belief Model Scale

The Champion's Health Belief Model Scale was originally developed to predict participation in mammography or breast cancer screening.[13] The scale has since been adapted to accommodate several languages and utilized to predict participation in other preventative health behaviors.[43-46] For the purposes of this study, the items within the scale were transformed to address participation in an ERIPP. For example, one of the susceptibility questions included in the scale, "It is likely that I will get breast cancer",[13] was changed to "It is likely I will sustain a lower extremity injury". The remainder of the scale was transformed in this fashion to make the scale pertinent to lower extremity injury prevention. The response choices for the participants were on a 5-point Likert scale from strongly agree (2) to strongly disagree (-2). There were a total of 41 items in the HBMS across 6 different subscales. The total score ranges for each subscale vary depending on the number of statements within each subscale. Scores are interpreted as falling within either the positive, neutral, or negative range. The number of

statements within each subscale can be found in Table III.3. Responses were totaled for each subscale for analyses.

Theory of Planned Behavior Scale

Questionnaires regarding the TPB are constructed utilizing the procedures outlined by Ajzen.[41] The direct measure items for the constructs of the TPB and ITP were developed utilizing the structure provided in the instructions on how to develop a TPB scale. An example question constructed to evaluate attitude was, “My participation in an injury prevention program would be beneficial”. Within the direct measures portion of the scale, there were 22 items included. The breakdown of numbers of statements within each subscale can be found within Table III.3. Responses to the statements were on a 5-point Likert scale ranging from strongly agree (2) to strongly disagree (-2). The total score ranges for each subscale vary depending on the number of statements within each subscale. Scores are interpreted as falling within either the positive, neutral, or negative range. To ensure that all aspects related to attitudes, perceived behavioral control, perceived subjective norms and ITP in an ERIPP, nine open-ended salient beliefs questions were added to the initial scale (Table III.1)

Individuals were given space to type in their response to each salient belief question. The responses were then coded by three researchers who were athletic trainers with previous experience performing qualitative analysis. One of the coders was involved in the initial scale development while the other two were not involved. Initially, ten randomly selected responses were assigned to each coder and the coders created a code book independently. The coders met to confirm the code book and the remaining responses were randomly assigned to the coders. Frequency counts of each code book response were calculated. In cases where more than 25% of the participants provided the same response, the response was transformed into a statement to

add into the future TPBS. In some cases, the statement was the same as an existing scale item and a new item was not added.

Disablement in the Physically Active Scale

The DPA is a generic patient-reported outcome measure assessing quality of life in respect to physical activity. The mDPA was established using two subscales providing a physical summary component (DPA-PSC) and a mental summary component (DPA-MSC).[49] The DPA-PSC contains 12 statements while the DPA-MSC contains 4 statements. Participants respond to each statement with a descriptor ranging from no problem (0) to severe (4). The responses for each component are added to create a physical component score and mental component score. The scores for the physical component range from 0-48. Higher scores are associated with increased functional impairment related to participation in physical activity. The scores for the mental component range from 0-16 with higher scores being associated with increased mental impairment related participating in physical activity. The mDPA has excellent internal consistencies within the two subscales ranging from 0.88-0.94.[49] Additionally, construct validity was established as the mDPA scores were strongly correlated to the original DPA.[49] The DPA was utilized within this study to determine if physical and mental function would influence behavioral determinants of ERIPP participation measured through the HBMS and TPBS.

Hospital Anxiety and Depression Scale

The HADS is a scale utilized to measure anxiety and depression related to health. There are two components of this scale which are anxiety and depression.[50] The anxiety and depression subscale each contain 7 statements. The participant responds according to a scale provided which ranges from 0-3. The total score for each subscale is derived from adding the responses for each

statement within the subscale. A score ranging from 0-7 is defined as normal, 8-10 borderline abnormal, and 11-21 abnormal. The psychometric properties of the HADS have previously been established. The HADS-anxiety had an internal consistency of 0.89 while the HADS-depression had an internal consistence of 0.86.[52] The HADS was utilized within this study to determine if anxiety and depression related to health may influence the behavioral determinants of ERIPP participation.

Exercise Self-Efficacy Scale

The ESES was used to measure the beliefs of an individual about their ability to participate in physical activity.[51] The ESES contains 10 statements related to confidence in participating in exercise or physical activity. Participants rate their confidence related to participating in physical activity by responding to statements along a scale from not true at all (1) to exactly true (4). Responses for each item are added to create a total score for the scale. Total scores range from 10-40. Higher scores are associated with greater confidence related to participating in physical activity while low scores are associated with decreased confidence in participating in physical activity. The internal consistencies were excellent ranging from 0.87-0.93.[51] Construct validity was established by correlation between scores on the ESES and Generalized Self-Efficacy Scale.[51] The ESES was utilized within this study to determine if self-efficacy related to physical activity influenced behavioral determinants of ERIPP participation.

Data Analysis

Means and standard deviations were calculated for the subscales of the HBMS, TPBS, DPA-PSC, DPA-MSC, HADS-anxiety, HADS-depression, and ESES. The internal consistencies for each construct of the HBMS and TPBS were calculated using Cronbach's alpha (SPSS,

Version 22) and used to determine if items should be removed from the scales. If the internal consistency (Cronbach's alpha) improved by more than 0.05 by removal of a statement, then the statement was removed.

Validity was assessed through a series of analyses involving the total scores from the individual subscales of the HBMS (perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy) and TPBS (attitudes, perceived subjective norms, perceived behavioral control, and intention), total scale scores from the DPA-PSC, DPA-MSC, HADS-anxiety, HADS-depression, and ESES, and the total score from the battery of questions which examined ITP which was incorporated into the TPBS. First, preliminary construct validity of the HBMS and TPBS subscales was examined through correlational analyses with the DPA-PSC, DPA-MSC, HADS-anxiety, HADS-depression, and ESES. Second, a series of correlational analyses between the HBMS and TPBS subscales was executed to examine redundancy between the scales. Finally, correlations between each HBMS and TPBS subscale and ITP was examined to determine how these scales influence ITP in an ERIPP. Spearman correlations were used for all correlation analyses. Alpha was set at $p \leq 0.05$ for all correlational analyses.

Results

The means and standard deviations for total scores of all subscales can be found in Table III.2. Statements within the perceived benefits of the HBMS (1 item), perceived barriers of the HBMS (1 item), perceived norms of the TPBS (1 item), and intention of the TPBS (1 item) were removed to improve internal consistency. The original and final internal consistencies of each subscale can be found in Table III.3. All other internal consistencies of the questions within the subscales did not improve when a question was removed, therefore all other questions were

retained. The final internal consistencies ranged from 0.60-0.90. The HBM susceptibility, HBM benefits, HBM barriers, HBM cues to action, HBM self-efficacy, TPB perceived subjective norm, and TPB perceived behavioral control had adequate internal consistency. However, the HBM severity, TPB attitudes, and TPB intention had inadequate internal consistencies. The final version of the HBMS (39 items) can be found in Table III.4**.** Two items were identified during the coding process due to the high frequency of responses from the salient beliefs questions to be added to the future TPBS. One statement was created regarding a perceived benefit of participating in an ERIPP: "My participating in an injury prevention program would improve my knowledge of lower extremity injuries and injury prevention programs". Additionally, a statement regarding a perceived barrier of participating in an ERIPP: "My participating in an injury prevention program would be dependent on the location of the program". The final version of the TPBS (22 items) can be found in Table III.5.

The DPA-PSC was positively and significantly correlated with HBM benefits ($r=0.47$, $p=0.001$), TPB subjective norms ($r=0.36$, $p=0.01$), and ITP ($r=0.44$, $p=0.002$). Additionally, the DPA-PSC was significantly and negatively correlated with HBM barriers ($r=-0.30$, $p=0.04$). The ESES was positively and significantly correlated with the HBM cues to action ($r=0.47$, $p=0.001$), and TPB attitudes ($r=0.32$, $p=0.03$. However, the DPA-MSC, HADS-anxiety, and HADS-depression were not significantly correlated with any of the subscales of the HBMS or TPBS ($p>0.05$). The correlation coefficients between the HBMS and TPBS subscales and the DPA-PSC, DPA-MSC, HADS-depression, HADS-anxiety, and ESES can be found in Table III.6.

The HBM perceived susceptibility and perceived severity subscales were not significantly correlated with any of the subscales of the TPB. All other subscales were correlated

with at least one other subscale. The correlations between HBMS and TPBS subscales can be found in Table III.7.

The HBM subscales including benefits, self-efficacy, and cues to action and the TPB subscales including attitudes, subjective norms, and perceived behavioral control were positively and significantly correlated with ITP in an ERIPP (r=0.29-0.59). The HBM barriers was negatively and significantly correlated with ITP (r=-0.41).

Discussion

The primary findings of this preliminary study were the HBMS and TPBS are viable instruments to assess behavioral determinants of ITP in an ERIPP. The internal consistencies of the items within each HBM and TPB subscale ranged from 0.60-0.90. The internal consistencies within the HBM severity, TPB attitudes, and TPB intention need to be improved. Additionally, participants identified two areas within the salient beliefs questions including a perceived benefit of improving knowledge and a perceived barrier of the location of the ERIPP that were added to the final instrument. The internal consistency of the subscales these questions were added to will need to be investigated within further research. Interestingly, significant inter-subscale correlations were identified across nearly all HBMS and TPBS subscales; however, none involved the HBM perceived susceptibility and perceived severity subscales. The DPA-PSC was the only additional scale that was significantly positively correlated with a subscale from the HBMS, TPBS, and ITP in an ERIPP. Future studies should continue to investigate the relationship between the DPA-PSC and HBMS and TPBS.

While most of the subscales had adequate internal consistencies, a few subscales within the HBMS and TPBS did not. The HBM severity, TPB attitudes, and TPB ITP internal consistencies fell below 0.70. There is a potential that expanding the number of participants, as

well as the breadth of response range via broader samples of active persons, within the study will improve the internal consistencies. The internal consistency of the subscales is important because the measure ensures that the statements of the subscale are assessing the construct they are associated with. In order to utilize the HBMS and TPBS effectively, it is important that all subscales have adequate internal consistency.

Most of the subscales of the HBMS correlated to those of the TPB, however others did not. Perceived susceptibility and severity from the HBM did not significantly correlate with any of the subscales within the TPBS. This lack of correlation may indicate that these subscales of the HBMS bring a unique perspective outside of the subscales of the TPBS. Additionally, these results may indicate the population utilized within this study requires further education regarding this aspect. Furthermore, many of the significant relationships between HBMS and TPBS subscales were of moderate strength (r=0.3-0.75). This indicates that there is some explained variance across subscales; however, the strength of these correlations does not suggest there is excessive redundancy. Therefore, utilizing both the HBMS and TPBS to assess behavioral determinants of ERIPP participation is warranted.

The DPA-PSC was the only additional scale to correlate to a subscale of the HBMS, TPBS, and ITP in an ERIPP. This indicates that physical function may influence the subscales of the HBMS and TPBS which would also influence ITP. Therefore, an individual with a history of a lower extremity injury that is still experiencing some physical impairment may have different behavioral determinants of ERIPP participation than an individual without any physical impairment. There is a possibility that intervention strategies may need to be tailored to individuals with different levels of physical dysfunction. Interestingly, the ESES was significantly correlated with HBM cues to action and TPB attitudes, but none of the other

subscales. There is a potential that participating in exercise and being confident in that ability influences the different cues that remind you to participate in an ERIPP. Participating in physical activity on a regular basis may in itself be a cue to remind an individual that preventing injuries and participating in an ERIPP are important. Individuals who are confident in their ability to participate in physical activity may have better attitudes regarding participation in ERIPPs when compared to those who are not confident in participating in physical activity. Although there was a correlation between confidence in participating in physical activity and two of the subscales, there was no correlation with ITP. Additionally, these results indicate that depression, anxiety, and exercise related self-efficacy may not influence an individual's ITP in an ERIPP. The DPA-PSC correlated with the most subscales from the HBMS and TPBS while the DPA-MSC, HADS depression, and HADS anxiety did not correlate with any of the subscales from the HBMS or TPBS. There is a possibility that the more mental aspect associated with the DPA-MSC, HADS-anxiety, and HADS-depression do not inform the behavioral determinants of ERIPP participation while the physical function aspect plays a much larger role.

Previous literature has investigated the behavioral determinants of ERIPPs within physically active individuals.[31,42] The scales utilized to evaluate the behavioral determinants have been guided by theoretical models. Utilizing theory to inform the development of the scales used to assess behavioral determinants of ERIPP participation may give clinicians a more robust depiction of how to maximize compliance by understanding their perceptions of this health behavior, especially if future interventions are also based on these theories. Previous researchers have used homogenous educational interventions to improve both attitudes towards ERIPP participation and compliance with the programs.[19,53] The educational interventions used in these studies were able to slightly improve attitudes toward injury prevention programs, but not actual

compliance or uptake. There is a potential that using the HBMS and TPBS developed in this study to first assess the behavioral determinants of ERIPP participation and then inform the development of educational interventions could lead to improved adoption and compliance. The subscales that were correlated the most to ITP could be targeted using an intervention.

In order for the scales to aid in an increase in compliance, they must be used to inform implementation strategies. For example. Martinez et al. determined the most important behavioral determinant of ERIPP participation for female high school athletes was the potential to reduce the risk factors associated with injury. Therefore, the perceived benefits of the ERIPP were most important to the users in this instance. The clinician could use this information and develop an educational intervention including the benefits of the ERIPP specifically highlighting the potential for reduced risk for lower extremity musculoskeletal injuries. The educational information could be delivered to the users prior to participating in the ERIPP to facilitate adoption and compliance of the program. Several reminders of the information could be periodically distributed over time to gain continued compliance. The implementation strategies that can be used to leverage ERIPP adoption and compliance will likely differ for various groups of users based on their perceptions and attitudes towards ERIIPs. Therefore, creating scales to assess the behavioral determinants of ERIPP participation is vitally important to the development of an implementation strategy.

This study was focused on the preliminary development of the HBMS and TPBS. As a result of the preliminary nature of this research, there were several limitations associated with this study which will be addressed through further development of the HBMS and TPBS prior to integration into clinical practice. First, the number of participants included in this study was limited which allowed us to performance preliminary scale development but it did not allow for

the evaluation of factor structure. Further research should evaluate the use of the scales within a larger population and the scales should be subjected to more advanced statistical procedures to confirm factor structure and identify clinically meaningful cut-scores. The number of participants within each physical activity group within this study did not permit comparison across subgroups of physically active adults. Future studies should compare behavioral determinants of ERIPP participation across different levels of physical activity participation. If behavioral determinants of ERIPP participation differ among groups, there is a possibility that interventions may need to be tailored for individuals within different physical activity groups. In order to determine if interventions employed to improve behavioral determinants of ERIPP participation are effective, minimal detectable change and clinically meaningful change for the HBMS and TPBS must be evaluated. Therefore, several aspects of the psychometric properties and utility of these instruments require additional investigation.

Implications for Clinical Practice

The initial development of the HBMS and TPBS indicate they may be promising instruments to assess the behavioral determinants of ERIPP participation within the physically active population. The preliminary information gained from these scales may provide more insight into adoption and compliance challenges for implementing ERIPPs in clinical settings. Additionally, the information gained from the scales may be used to inform interventions to improve compliance of ERIPPs. These scales may aid clinicians in gaining a better picture of the attitudes and perceptions of the intended user of an ERIPP and developing effective interventions based on the information gained.

Table III.1. Salient Beliefs Questions from the Theory of Planned Behavior Scale

Question
1.What do you see as the advantages of participating in an injury prevention program?
2.What do you see as the disadvantages of participating in an injury prevention program?
3.What else comes to mind when you think about participating in an injury prevention program?
4.List the individuals or groups who would approve or think you should participate in an injury prevention program.
5.List the individuals who would disapprove or think you should not participate in an injury prevention program.
6.List the individuals who are most likely to participate in an injury prevention program
7.List the individuals who are least likely to participate in an injury prevention program.
8.List any factors or circumstances that would make it easy to participate in an injury prevention program
9.List any factors that would make it difficult or prevent you from participating in an injury prevention program.

Table III.2. Means and Standard Deviations of Total Scores for Subscales

Subscale	Mean±SD
HBM Susceptibility	-1.18±4.96
HBM Severity	-3.39±5.06
HBM Benefits	4.86±3.00
HBM Barriers	-3.67±3.99
HBM Cues to Action	7.96±4.91
HBM Self-Efficacy	5.31±5.83
TPB Attitudes	4.33±3.01
TPB Perceived Subjective Norm	6.79±3.11
TPB Perceived Behavioral Control	7.26±2.28
TPB Intention	4.40±2.24
DPA-PSC	11.10±10.52
DPA-MSC	4.50±4.16
HADS-Anxiety	7.85±3.34
HADS-Depression	3.26±2.53
ESES	33.91±4.21

HBM: Health Belief Model
TPB: Theory of Planned Behavior
DPA-PSC: Disablement in the Physically Active Scale-Physical Component Score
DPA-MSC: Disablement in the Physically Active Scale-Mental Component Score
HADS: Health Anxiety and Depression Scale
ESES: Exercise Self-Efficacy Scale

Table III.3. Internal Consistencies of Statements within the HBMS and TPBS

Subscale	Initial Number of Statements	Initial Internal Consistency	Final Number of Statements	Final Internal Consistency
HBM Susceptibility	5	0.90	5	0.90
HBM Severity	8	0.68	8	0.68
HBM Benefits	6	0.78	5	0.79
HBM Barriers	6	0.72	5	0.83
HBM Cues to Action	9	0.70	9	0.70
HBM Self-Efficacy	7	0.84	7	0.84
TPB Attitudes	6	0.60	6	0.60
TPB Perceived Subjective Norm	6	0.83	5	0.90
TPB Perceived Behavioral Control	5	0.72	5	0.72
TPB Intention	5	0.57	4	0.68

HBM=Health Belief Model
TPB=Theory of Planned Behavior

Table III.4. Final Health Belief Model Scale

Susceptibility
It is extremely likely I will sustain a lower extremity injury
I feel I will get a lower extremity injury in the future
There is a good possibility I will get a lower extremity injury within the next 10 years
My chances of sustaining a lower extremity injury are great
I am more likely than other athletes to get a lower extremity injury
Severity
The thought of a lower extremity injury scares me
When I think about lower extremity injuries, my heart beats faster
I am afraid to think about lower extremity injuries
Problems I would experience as a result of a lower extremity injury would last a long time
A lower extremity injury would threaten a relationship with my boyfriend/girlfriend, teammates, or parents
A lower extremity injury would affect my academic performance
If I had a lower extremity injury, my whole life would change
If I sustained a lower extremity injury, I would suffer consequences from it for up to 5 years
Benefits
When I do injury prevention programs I feel good about myself
Participation in an injury prevention program will improve my athletic performance
Completing an injury prevention program will decrease my risk of lower extremity injury
If I complete an injury prevention program during the next year, I will decrease my chances of sustaining a lower extremity injury
If I complete an injury prevention program regularly, I will decrease my chances of requiring surgery if a lower extremity injury does occur
Barriers
I feel funny doing injury prevention programs
Participating in an Injury prevention program will be embarrassing to me
Participating in an injury prevention program will take too much time
Participating in an injury prevention program will be unpleasant or painful
I don’t have the equipment to do an injury prevention program
Cues to Action
I want to discover health problems early
Maintaining good health is extremely important to me
I search for new information to improve my health
I feel it is important to carry out activities which will improve my health
I eat well balanced meals
I have regular health check-ups even if I am not sick
I seek out ways to prevent illnesses and/or injuries
My coach has recommended participating in an injury prevention program
A healthcare professional (physician, athletic trainer, physical therapist) has recommended I participate in an injury prevention program

Table III.4. Continued

Self-Efficacy
I know how to perform an injury prevention program
I am confident I can perform an injury prevention program correctly
I have performed an injury prevention program
I would feel confident in performing an injury prevention program if given educational materials on the program
I would feel confident in performing an injury prevention program if it was led by my coach
I would feel confident in performing an injury prevention program if it was led by an athletic trainer
I would feel confident in performing an injury prevention program if it was led by a strength and conditioning coach

Table III.5. Final Theory of Planned Behavior Scale

Attitudes
My participating in an injury prevention program would be beneficial
My participating in an injury prevention program would be pleasant
My participating in an injury prevention program would decrease my chances of having a lower extremity injury
My participating in an injury prevention program would improve my athletic performance
My participating in an injury prevention program would improve my knowledge of lower extremity injuries and injury prevention programs
My participating in an injury prevention program would take too much time
My participating in an injury prevention program would cost too much
My participating in an injury prevention program would be dependent on the location of the program
Perceived Subjective Norms
Most people who are important to me approve of me participating in an injury prevention program
My healthcare providers (doctor/athletic trainer/physical therapist) would approve of my participation in an injury prevention program
My coach/strength coach would approve of my participation in an injury prevention program
My parents would approve of my participation in an injury prevention program
My teammates/friends would approve of my participation in an injury prevention program
Perceived Behavioral Control
I am confident that I can participate in an injury prevention program
My participation in an injury prevention program is up to me
If my entire team was participating in an injury prevention program, I would be more likely to participate
If there were evidence injury prevention programs improved athletic performance, I would be more likely to participate
If I had access to an injury prevention program, I would be more likely to participate
Intention
I intend to participate in an injury prevention program
If my team was participating in an injury prevention program, I would participate too
If I was given an injury prevention program to perform at home, I would participate
If a healthcare provider led an injury prevention program session, I would attend

Table III.6. Correlations between Health Belief Model and Theory of Planned Behavior Subscales and DPA, HADS, and ESES

Subscales	DPA Physical	DPA Mental	HADS Anxiety	HADS Depression	ESES
HBM Susceptibility	.166	.063	.018	-.045	.153
HBM Severity	.213	.277	.144	.105	-.087
HBM Benefits	.473*	.063	-.047	-.002	-.117
HBM Barriers	-.295*	-.009	.136	.167	-.142
HBM Cues to Action	.113	-.058	-.029	-.164	.471*
HBM Self-Efficacy	.276	-.127	-.059	-.057	.219
TPB Attitudes	.150	-.150	-.049	-.198	.319*
TPB Subjective Norms	.359*	.042	.042	-.063	.178
TPB Perceived Behavioral Control	.073	.178	.168	.082	.198
TPB Intention	.443*	.011	.035	-.056	.032

HBM=Health Belief Model
TPB=Theory of Planned Behavior
DPA=Disablement in the Physically Active Scale
HADS=Hospital Anxiety and Depression Scale
ESES=Exercise Self-Efficacy Scale
*Significant at .05 level

Table III.7. Correlations between the Health Belief Model and Theory of Planned Behavior Constructs

	HBM Susceptibility	HBM Severity	HBM Benefits	HBM Barriers	HBM Cues to Action	HBM Self-Efficacy	TPB Attitudes	TPB Subjective Norms	TPB Perceived Behavioral Control
HBM Severity	.079	-							
HBM Benefits	-.001	-.082	-						
HBM Barriers	.048	.043	-.748*	-					
HBM Cues to Action	-.054	-.160	.243	-.355*	-				
HBM Self-Efficacy	-.008	-.174	.410*	-.527*	.382*	-			
TPB Attitudes	-.032	-.256	.454*	-.536*	.454*	.554*	-		
TPB Subjective Norms	.026	.011	.568*	-.580*	.295*	.323*	.605*	-	
TPB Perceived Behavioral Control	-.128	-.109	.407*	-.427*	.241	.302*	.350*	.655*	-
TPB Intention	.064	-.043	.525*	-.413*	.293*	.305*	.472*	.588*	.524*

HBM=Health Belief Model
TPB=Theory of Planned Behavior
*Significant at .05 level

CHAPTER IV

PROJECT III: HEALTH BELIEF MODEL SCALE AND THEORY OF PLANNED BEHAVIOR SCALE TO ASSESS ATTITUDES AND PERCEPTIONS TOWARDS INJURY PREVENTION PROGRAMS: AN EXPLORATORY FACTOR ANALYSIS

Introduction

Lower extremity musculoskeletal injuries are common within physically active individuals who participate in sport and recreation.[1,3] Musculoskeletal injuries; such as ankle sprains and anterior cruciate ligament (ACL) tears, are a public health concern due to their short and long term negative consequences and the associated costs incurred over the lifespan. These injuries cause short-term deficits such as loss of range of motion, loss of strength, postural control insufficiencies, joint laxity and kinesiophobia.[54-56] Additionally, these injuries lead to long-term concerns such as the early development of post-traumatic osteoarthritis and decreased health-related quality of life.[4,5] The overall treatment costs for these injuries generate a large economic burden for both the patient and healthcare system.[6,7,57] The functional deficits, psychological concerns, and economic burden associated with these injuries supports the need to develop injury prevention efforts rather than focus on treating musculoskeletal conditions.

Exercise-related injury prevention programs (ERIPPs) were developed primarily to reduce the occurrence of lower extremity musculoskeletal injuries. ERIPPs are often composed of neuromuscular based exercises that aim to improve balance, range of motion, strength, and agility. Several studies have suggested that these programs effectively mitigate the risk of musculoskeletal injury occurrence.[10] However, the effectiveness of these programs is limited by the users' adoption s and compliance to complete the recommended exercises throughout the

recommended duration.[11] The potential reasons that young, physically active individuals fail to adopt and adhere to ERIPPs is unclear and presents a barrier to more consistent utilization of these programs in clinical practice.

Many healthcare fields have utilized health and behavioral science models or frameworks to better understand compliance with preventative health behaviors.[14,15] Two of the most commonly used theoretical models were the Health Belief Model (HBM) and Theory of Planned Behavior (TPB).[16] Both models utilize perceptions and attitudes towards the preventative health behavior to predict participation in the behavior.[17,18] However, there is a lack of use of these theories within ERIPP related research.[16] A systematic review published in 2010 revealed that only 11% of all sport-related injury prevention research contained a behavioral or social theoretical model. Strikingly, none of the articles that were specific to sport-related ERIPP research contained any mention of behavioral or social theoretical models.[16] A majority of the studies that did utilize theoretical models were focused on protective equipment adoption and adherence. Several studies have investigated attitudes towards ERIPP participation since the publishing of the last systematic review. The HBM and TPB were used to better understand the perceptions of users towards ERIPPs.[27-29] Within these studies, there was still a lack of scale design directly based on the theoretical model or framework used. Utilizing these theoretical models or frameworks to design the scale could provide insight into the reasons for poor ERIPP compliance in physically active individuals. This information could lead to the development of implementation strategies to increase uptake of ERIPPs and compliance with ERIPPs.

Due to the lack of use of theoretical models within ERIPP-related research, there are very few scales that have been validated to assess behavioral determinants. A previous study[58] developed a HBM scale (HBMS) and TPB scale (TPBS) to assess behavioral determinants of

ERIPP participation.[58] The scales were preliminary investigated within a small population of physically active adults. Most of the subscales showed acceptable internal consistency with the exception of HBMS perceived severity, TPBS attitudes, and intention to participate. Due to the low internal consistency of a few subscales and the limited sample population, further psychometric testing of the scales ability to assess the behavioral determinants of ERIPP participation is warranted. Therefore, the purposes of this study were to examine the psychometric properties of the HBMS and TPBS, and determine construct validity by evaluating which subscales were most associated with intention to participate in an ERIPP within physically active adults.

Methods

The overall design of this study was cross-sectional. Participants were administered a demographic questionnaire, the Disablement of the Physically Active Scale (DPA), Health Belief Model Scale (HBMS), and Theory of Planned Behavior Scale (TPBS) on one occasion.

Participants

Two hundred and eighty-four (Females=150, Males=134; Age=21.17±2.78 years; Height: 172.37±18.98 cm; Mass: 75.00±14.99 kg) physically active adults volunteered to participate in this study. Participants were considered physically active if they participated in a moderate level of exercise for a minimum of 90 minutes per week. Full demographics on the participants included within this study can be found in Table IV.1. Participants were recruited from a large public university and small liberal arts college using flyers on campus, club sport and collegiate athletic team meetings, and classroom recruitment.

Instrumentation

Disablement in the Physically Active

The DPA is a generic patient-reported outcome measure that was designed to assess quality of life in physically activity people.[49] This study utilized a modified version of the DPA which contained two subscales including the 12-item physical summary component (DPA-PSC) and the 4-item mental summary component (DPA-MSC). Each item was scored on a Likert scale ranging from no problem (0) to severe (4). The responses for each item were summed to create a total score for each subscale. Higher scores on both subscales are associated with increased physical and mental health-related quality of life impairments. The subscales of the modified DPA have been previously validated and have demonstrated excellent internal consistencies ranging from 0.88-0.94.[49]

Health Belief Model Scale

The HBMS was adapted from Champion's Health Belief Model Scale originally aimed to assess perceptions and attitudes regarding preventative mammography screenings.[13] The scale was altered by inserting language consistent with lower extremity injuries and injury prevention programs. The HBMS contained 39 items to assess the six constructs of the Health Belief Model in relation to ERIPP participation.[58] The original HBMS contained response choices along a 5-point Likert Scale. The response choices were expanded within this study to a 7-point Likert scale from strongly agree (3) to strongly disagree (-3). The internal consistencies of the subscales have been previously reported as acceptable (0.70-0.90) with the exception of the perceived severity subscale (0.68).

Theory of Planned Behavior Scale

The TPBS was created using Ajzen's guidelines to assess the constructs of the TPB in relation to ERIPP participation.[41] The scale also included an assessment of the participant's intent to participate in an ERIPP. The original scale contained 22 items with response choices

ranging along a 5-point Likert scale.[58] The response choices were expanded for this study to a 7-point Likert scale ranging from strongly agree (3) to strongly disagree (-3). Preliminary assessment of the TPBS subscales identified acceptable internal consistencies (0.72-0.90) with the exception of the perceived attitudes and intention subscales (0.60-0.68).

Procedures

Packets were distributed to potential participants containing a cover letter and all of the scales. The cover letter explained the purpose of the study and voluntary nature of the study. Consent was assumed if the participant decided to complete the questionnaires and participate in the study after reading the cover letter. All questionnaires were completed using pen and paper format and returned to the researchers. The survey pack contained a demographic questionnaire and the DPA, HBMS, and TPBS. The demographic questionnaire assessed information related to gender, previous history of injury, type of participation in physical activity, and previous experience with ERIPPs. All demographic information and scale data were entered into an Excel spreadsheet for data processing and analysis.

Data Analysis

Participants who were missing more than 10% of the scale data (HBMS and TPBS) were excluded from analysis. In instances where participants were missing less than 10% of scale data, multiple imputation (SPSS version 24) was used to estimate missing data points. Exploratory factor analysis[59] (EFA) was used to evaluate the potential factors of the HBMS and TPBS. A factor loading cutoff score of 0.40 was used for item retention. The factor loading patterns and meaningful relationships for the grouped items were used to determine the ideal factor structure. If items failed to load with a factor, they were dropped. Cronbach's alpha was used to determine the internal consistency of the subscales created by each factor. Once factors were identified

through the EFA, total scores were calculated for each factor. A series of Spearman correlations were performed between the HBMS subscales and TPBS subscales to assess redundancy between the two scales. Additionally, correlations were evaluated and interpreted (very weak: $r<0.3$, weak: $0.3<r<0.5$, moderate: $0.5<r<0.7$, or strong: $r>0.7$) for the HBMS and TPBS with the DPA-MSC and DPA-PSC to determine convergent reliability.

A combination of t-tests and one-way ANOVAs were used to determine whether differences in intention existed between individuals with different demographic variables. An independent t-test was used to compare intention within gender (Males/Females), those with and without a previous history of injury, and those with and without previous exposure to an ERIPP. An ANOVA was used to compare intention between individuals of different levels of participation in physical activity (Recreation, Club sport, Collegiate). In instances where intention was different within the individuals of differing demographic variables, the variable was used within the regression model. A multiple linear regression was used to determine if the subscales of the HBMS and TPBS could predict intention to participate in an ERIPP. Partial eta squared was calculated for each significant variable to determine the strength of the prediction (small: $0.06>\eta^2\geq0.01$, moderate: $0.14>\eta^2\geq0.07$, or large: $\eta^2\geq0.15$).[60] Alpha was set a $P\leq0.05$ for all analyses.

Results

The Kaiser-Meyer-Olkin (KMO) Measure of Sampling value was acceptable (KMO= 0.83). The EFA for the HBMS revealed 9 factors were present within the scale accounting for a total of 70.12% of the variance (Table IV.2). The (KMO) Measure of Sampling value was acceptable (KMO=0.88). The EFA for the TPBS revealed 5 factors were present within the scale and accounted for a total of 63.89% of the variance (Table IV.3). The internal consistencies for

the subscales of the HBMS and TPBS were all acceptable and can be found in Table IV.2 and IV.3. The finalized version of the HBMS can be found in Table IV.4 while the finalized TPBS can be found in Table IV.5. Most of the subscales of the HBMS and TPBS had small correlations with a few falling within the moderate range and a few having no significant correlation. However, the correlation coefficients between the scales were >0.80[61] indicating a lack of redundancy between the two scales. The DPA-PSC and DPA-MSC were positively and significantly correlated with HBMS perceived susceptibility, HBMS fear of injury, and HBMS perceived consequences. Additionally, the DPA-MSC was negatively and significantly correlated with the TPBS perceived benefits. The correlations between the HBMS subscales, TPBS subscales, and DPA subscales can be found in Table IV.6 [62]

There was no significant difference in intention to participate between males and females ($t(279)=-0.77$, $p=0.44$), level of participation in physical activity ($F(2,279)=0.81$, $p=0.45$), or previous history of an injury ($t(280)=0.35$, $p=0.73$). Individuals with previous experience (PE) with an ERIPP had a higher intention to participate than those with no previous experience (NPE) with an ERIPP ($t(280)=-2.05$, PE=9.03±4.06; NPE=7.94±4.84, $p=0.04$). Therefore, previous experience with an ERIPP, DPA-PSC, DPA-MSC, HBMS subscales, and TPBS subscales were included within the model as the potential predictors while the outcome was intention to participate in an ERIPP. The linear regression (Table IV.7) revealed a significant relationship between the TPBS perceived benefits, TPBS Perceived Social Norms, TPBS Perceived Social Influence, HBMS Perceived Benefits, HBMS Individual Self-Efficacy, HBMS General Health Cues, HBMS Perceived Barriers, and intention to participate in an ERIPP ($F(16, 255)=22.53$, $R^2=0.59$, $p<0.001$). The strongest association was the positive and moderate association between the TPBS social influence and intention to participate in an ERIPP. There

was a small and positive association between the TPBS perceived benefits, TPBS perceived social norms, HBMS perceived benefits, HBMS individual self-efficacy, and HBMS general health cues with intention to participate in an ERIPP. An additional small and negative association between the HBMS perceived barriers with intention to participate in an ERIPP existed.

Discussion

The main findings of this study were the strong psychometric properties of the HBMS and TPBS within physically active adults. Nine factors were identified within the HBMS including perceived susceptibility, perceived severity, fear of injury, perceived benefits, perceived barriers, individual self-efficacy, community led self-efficacy, general health cues, and external health cues. Five factors were identified within the TPBS including perceived benefits, perceived barriers, perceived social norms, perceived social influence, and intention. The nine factors of the HBMS demonstrated acceptable internal consistencies and the five factors of the TPBS also demonstrated acceptable internal consistencies. Additionally, the behavioral determinants which were associated with intention to participate were identified. Perceived social influence, perceived social norm, and individual-self efficacy were the behavioral determinants most strongly associated with intention to participate followed by benefits, general health cues, and barriers.

There were nine factors identified within the HBMS. Most of these factors directly aligned to one of the HBM constructs, however some were slightly different. Three of the factors directly aligned with a construct of the HBM: perceived susceptibility, perceived benefits, and perceived barriers. The perceived severity construct split into two factors containing fear of injury and perceived consequences. The self-efficacy construct split into two specific types of

self-efficacy including individual self-efficacy and community led self-efficacy. This distinction is important and may lead to further understanding of reasons for low implementation amongst physically active individuals. Some users of ERIPPs may need to complete the program as an individual while others would participate in a group or team setting. The construct of cues to action split into general health cues and external health cues. The general health cues assess whether the individual participates in general preventative health behaviors such as annual physicals and check-ups with a physician. The external health cues assessed whether the individual has been told by a coach or healthcare provider to participate in an ERIPP. The factors identified within the HBMS have allowed for more distinction of some of the constructs of the HBM which may lead to better understanding the reasons why implementation is lacking.

Five factors were identified within the TPBS. Most of these factors aligned well with the constructs of the TPB while a few factors were unique. Perceived subjective norms and intention were directly aligned with constructs of the TPB. The attitudes construct split into two types of attitudes which were better described as the benefits of participating in and ERIPP and the barriers to participating in an ERIPP. The perceived behavioral control construct was not represented by any of the factors identified. Most of the original questions created for this construct fell into the intention to participate factor. This alignment seems appropriate as confidence in participating in an ERIPP should transform to intention to participate in such a program. The last factor that was identified was social influence. This factor assessed the influence a team or group setting would have on the individual as well as evidence regarding the effectiveness of the ERIPP to prevent injuries. This new factor sheds light on the importance of the team/community aspect of participating in injury prevention strategies, as well as information that would be gained through the community on the effectiveness of the ERIPP. The factors

identified within the TPBS provided a representation of the TPB with the inclusion of a new factor that assessed the role of social influences on participating in an ERIPP.

Overall, a majority of the subscales from the HBMS and TPBS had weak to moderate correlations with each other. Perceived susceptibility, fear of injury, and perceived severity were the only subscales which were not significantly correlated to intention to participate. Additionally, those subscales lacked significant correlation to perceived benefits, perceived social norms, and perceived social influence. These results indicate these areas of the HBMS may be assessing a unique aspect of behavioral determinants of ERIPP participation. The DPA-PSC had a positive and weak correlation with perceived susceptibility, positive and very weak correlation with fear of injury, positive and very weak correlation with perceived consequences. Additionally, the DPA-MSC had a positive and very weak correlation with perceived susceptibility, positive and very weak correlation with fear of injury, positive and very weak correlation with perceived consequences, and negative and very weak correlation with perceived benefits.. Individuals with functional and mental impairments related to participation in physical activity have a higher fear of injury, understand the susceptibility to injury, and perceive the consequences associated with injury. These individuals have likely suffered an injury recently which resulted in the physical and mental impairments which would likely make them more aware of the chance of injury and negative impacts of those injuries. Individuals with mental impairments in relation to physical activity were more likely to not see the benefits of participating in an ERIPP. Potentially, these individuals did not think mental impairments could be prevented by participating in an ERIPP. Neither the DPA-PSC nor DPA-MSC were significantly correlated with intention to participate indicating functional and mental impairments do not directly influence intention to participate in an ERIPP.

The results of the study indicated social influence was most associated with intention to participate followed by social norms, individual self-efficacy, benefits, general health cues, and barriers. Social influence and social norms indicate that most users rely on the community and value their opinion regarding whether they should participate in an ERIPP. This information indicates implementing an ERIPP within a team or group setting would most likely be more beneficial than an individual setting. Additionally, the social influence subscale evaluates the importance of available data to support the effectiveness of the ERIPP to improve athletic performance. Interventions to improve the uptake of ERIPPs may want to focus on providing supportive data for ERIPPs regarding improvements in athletic performance and create group environments for the ERIPP to be completed within. The importance of individual self-efficacy indicates the individual must feel confident completing the program as an individual. Potentially one-on-one meetings to instruct the ERIPP and practice the exercises may improve participation rates. The benefits of participating in an ERIPP and barriers to implementing the program were also associated with intention to participate. Therefore, there is a potential for an educational piece to include the benefits of the program, barriers to implementing the program, and strategies to overcome the barriers. One potential area to include more information on benefits may be the improvement in athletic performance due to participation in an ERIPP. There are few studies which show improvements in athletic performance due to participation in an ERIPP.[62,63] The data presenting the improvements in athletic performance should potentially be included within an educational intervention when presenting the benefits of participating in an ERIPP. General health cues were associated with intention to participate in an ERIPP indicating that individuals who already participate in other preventative health behaviors are more likely to participate in an ERIPP. This information indicates implementation strategies may be more effective within the

individuals with high general health cues while more intense strategies may be needed for those with low general health cues. Information regarding the subscales which are most associated with intention to participate can be used to transform implementation strategies which may be more effective at improving participation rates.

Limitations

There were several limitations associated with this study. Participants within the study only included physically active individuals between the ages of 18 and 35 who were enrolled in academic programs on a college campus. Therefore, the psychometric properties of the HBMS and TPBS have only been validated within this population. Future research should investigate the psychometric properties of the scales within other populations. Participants self-reported responses on the HBMS, TPBS, DPA-PSC, and DPA-MSC which could have led to response bias or the participants responding how they believed the researchers would want them to respond. Additionally, current ERIPP participation rates were not measured in this study and intention to participate was used for the linear regression. Future research should measure current participation status to more accurately predict participation rather than intention to participate.

Conclusion

The results of this study indicate the HBMS and TPBS have sound psychometric properties and can be used to assess behavioral determinants of ERIPP participation. Future research should assess behavioral determinants of ERIPP participation using these scales within diverse populations of differing physical activity level and demographic variables. The information gained from these studies could be used to inform the development of implementation strategies to improve adoption and participation in ERIPPs. Additional areas of future research may be investigating the benefits of ERIPPs. There is substantial research

supporting the use of ERIPPs to decrease the risk of lower extremity injury.[10,64] However, there are other important benefits individuals may receive from participating in an ERIPP such as an improvement in athletic performance or improved confidence and self-efficacy related to participating in physical activity. Future research should investigate additional benefits of participating in an ERIPP and the magnitude of those benefits.

Table IV.1. Participant Demographics

Variable	Recreational	Club Sport	Collegiate
Age (years)	22.53±3.46	20.36±1.51	20.03±1.54
Height (cm)	171.53±10.91	175.84±28.13	170.92±19.18
Mass (kg)	75.46±14.70	76.85±16.33	73.31±14.15
Gender (M/F)	67/58	32/36	34/56
Previous exposure to ERIPP (Y/N)	62/64	24/44	73/17
Previous history of injury (Y/N)	92/34	51/17	82/8

Table IV.2. Health Belief Model Scale Factor Loading

Factor	Number of items	Loading Range	Eigenvalue	Percent of Variance	Internal Consistency
1.Perceived Susceptibility	5	0.79-0.91	6.91	17.72%	0.95
2.Perceived Benefits	5	0.41-0.90	6.43	16.48%	0.86
3.General Health Cues	6	0.48-0.91	2.94	7.54%	0.80
4.Perceived Barriers	5	0.42-0.86	2.57	6.59%	0.81
5.Perceived Consequences	5	0.61-0.80	2.58	6.59%	0.85
6.Fear of Injury	3	0.64-0.93	2.15	5.52%	0.85
7.Community led self-efficacy	3	0.64-0.89	1.64	4.20%	0.82
8.Individual self-efficacy	3	0.73-0.84	1.32	3.39%	0.81
9.External Health Cues	3	0.43-0.85	1.16	2.96%	0.84

Table IV.3. Theory of Planned Behavior Scale Factor Loading

Factor	Number of items	Loading Range	Eigenvalue	Percent of Variance	Internal Consistency
1.Perceived Benefits	5	0.72-0.86	7.78	35.36%	0.87
2.Perceived Social Norms	6	0.48-0.93	2.27	10.29%	0.84
3.Intention to Participate	4	0.56-0.78	1.57	7.12%	0.78
4.Perceived Barriers	3	0.53-0.95	1.29	5.85%	0.81
5.Perceived Social Influence	3	0.73-0.74	1.16	5.27%	0.77

Table IV.4. Health Belief Model Scale Items

Perceived Susceptibility
It is extremely likely I will sustain a lower extremity injury
I feel I will get a lower extremity injury in the future
There is a good possibility I will get a lower extremity injury within the next 10 years
My chances of sustaining a lower extremity injury are great
I am more likely than other athletes to get a lower extremity injury
Fear of Injury
The thought of a lower extremity injury scares me
When I think about lower extremity injuries, my heart beats faster
I am afraid to think about lower extremity injuries
Perceived Consequences
Problems I would experience as a result of a lower extremity injury would last a long time
A lower extremity injury would threaten a relationship with my boyfriend/girlfriend, teammates, or parents
A lower extremity injury would affect my academic performance
If I had a lower extremity injury, my whole life would change
If I sustained a lower extremity injury, I would suffer consequences from it for up to 5 years
Perceived Benefits
When I do injury prevention programs I feel good about myself
Participation in an injury prevention program will improve my athletic performance
Completing an injury prevention program will decrease my risk of lower extremity injury
If I complete an injury prevention program during the next year, I will decrease my chances of sustaining a lower extremity injury
If I complete an injury prevention program regularly, I will decrease my chances of requiring surgery if a lower extremity injury does occur
Perceived Barriers
I feel funny doing injury prevention programs
Participating in an Injury prevention program will be embarrassing to me
Participating in an injury prevention program will take too much time
Participating in an injury prevention program will be unpleasant or painful
I don’t have the equipment to do an injury prevention program
Individual Self-Efficacy
I know how to perform an injury prevention program
I am confident I can perform an injury prevention program correctly
I have performed an injury prevention program
Community led Self-Efficacy
I would feel confident in performing an injury prevention program if it was led by my coach
I would feel confident in performing an injury prevention program if it was led by an athletic trainer
I would feel confident in performing an injury prevention program if it was led by a strength and conditioning coach

Table IV.4. Continued

General Health Cues
I want to discover health problems early
Maintaining good health is extremely important to me
I search for new information to improve my health
I feel it is important to carry out activities which will improve my health
I eat well balanced meals
I seek out ways to prevent illnesses and/or injuries
External Health Cues
My coach has recommended participating in an injury prevention program
A healthcare professional (physician, athletic trainer, physical therapist) has recommended I participate in an injury prevention program

Table IV.5. Theory of Planned Behavior Scale Items

Benefits
My participating in an injury prevention program would be beneficial
My participating in an injury prevention program would be pleasant
My participating in an injury prevention program would decrease my chances of having a lower extremity injury
My participating in an injury prevention program would improve my athletic performance
My participating in an injury prevention program would improve my knowledge of lower extremity injuries and injury prevention programs
Barriers
My participating in an injury prevention program would take too much time
My participating in an injury prevention program would cost too much
My participating in an injury prevention program would be dependent on the location of the program
Perceived Social Norms
Most people who are important to me approve of me participating in an injury prevention program
My healthcare providers (doctor/athletic trainer/physical therapist) would approve of my participation in an injury prevention program
My parents would approve of my participation in an injury prevention program
My teammates/friends would approve of my participation in an injury prevention program
Social Influence
If my entire team was participating in an injury prevention program, I would be more likely to participate
If there were evidence injury prevention programs improved athletic performance, I would be more likely to participate
If my team was participating in an injury prevention program, I would participate too
Intention to Participate
I am confident that I can participate in an injury prevention program
If I had access to an injury prevention program, I would be more likely to participate
I intend to participate in an injury prevention program
If I was given an injury prevention program to perform at home, I would participate
If a healthcare provider led an injury prevention program session, I would attend

Table IV.6. Correlations between the Subscales of the Health Belief Model Scale, Theory of Planned Behavior Scale, and Disablement in the Physically Active Scale

	DPA-MSC	TPBS BEN	TPBS BARR	TPBS SN	TPBS SI	TPBS ITP	HBMS SUS	HBMS FOI	HBMS CON	HBMS BEN	HBMS BARR	HBMS ISE	HBMS CLSE	HBMS GHC	HBMS EHC
DPA-PSC	0.428*	-0.014	0.02	0.060	0.007	-.055	0.39*	0.16*	0.15*	0.019	0.01	0.065	-0.07	0.10	.104
DPA-MSC	-	-.123*	.076	-.076	-.045	-.110	.169*	.119*	.169*	-.048	.059	.119	-.050	-.030	-.041
TPBS BEN		-	.157*	.635*	.439*	.602*	-.049	.046	-.063	.593*	-.297*	.152*	.392*	.348*	.251*
TPBS BARR			-	-.180*	-.038	-.184*	.142*	.085	.150*	-.154*	.427*	.152*	-.121*	.006	-.121*
TPBS SN				-	.463*	.626*	.007	.085	-.036	.539*	-.321*	.180*	.446*	.381*	.359*
TPBS SI					-	.564*	.035	.044	-.043	.360*	-.177*	.028	.405*	.323*	.173*
TPBS ITP						-	-.034	.111	-.023	.535*	-.344*	.261*	.468*	.413*	.391*
HBMS SUS							-	.269*	.386*	.011	.205*	.048	-.072	-.072	.219*
HBMS FOI								-	.575*	.159*	.181*	.120*	.022	.044	.206*
HBMS CON									-	.085	.374*	.031	-.009	.112	.196*
HBMS BEN										-	.213*	.206*	.507*	.370*	.304*
HBMS BARR											-	-.053	-.173*	-.205*	-.032
HBMS ISE												-	.187*	.168*	.408*
HBMS CLSE													-	.409*	.261*
HBMS GHC														-	.243*

DPA-PSC=Disablement in the Physically Active-Physical Component, DPA-MSC=Disablement in the Physically Active-Mental Component, HBMS=Health Belief Model Scale, TPBS=Theory of Planned Behavior Scale, BEN=Perceived Benefits, BARR=Perceived Barriers, SN=Perceived Social Norms, SI=Social Influence, ITP Intention to Participate, SUS=Perceived Susceptibility, FOI=Fear of Injury, CON=Perceived Consequences, ISE=Individual Self-Efficacy, CLSE=Community led Self-Efficacy, GHC=General Health Cues, EHC=External Health Cues

Table IV.7. Linear Regression Results for Association with Intention to Participate

Variable	B	Standard Error	P-Value	Partial Eta Squared
Previous History of ERIPP	0.75	0.42	0.08	0.01
DPA-PSC	-0.09	0.22	0.69	0.00
DPA-MSC	-0.27	0.20	0.19	0.01
TPBS Perceived Benefits	0.74	0.25	0.003	0.03
TPBS Perceived Barriers	-0.12	0.21	0.58	0.00
TPBS Perceived Social Norm	0.89	0.25	0.001	0.05
TPBS Perceived Social Influence	1.15	0.21	0.000	0.10
HBMS Perceived Susceptibility	-0.15	0.22	0.51	0.00
HBMS Fear of Injury	0.22	0.23	0.33	0.004
HBMS Perceived Consequences	0.04	0.25	0.88	0.00
HBMS Perceived Benefits	0.51	0.25	0.04	0.02
HBMS Perceived Barriers	-0.52	0.22	0.02	0.02
HBMS Individual Self-Efficacy	0.73	0.22	0.001	0.04
HBMS Community led Self-Efficacy	0.12	0.22	0.03	0.02
HBMS General Health Cues	0.46	0.21	0.03	0.02
HBMS External Health Cues	0.38	0.22	0.09	0.01

HBMS=Health Belief Model Scale

TPBS=Theory of Planned Behavior Scale

CHAPTER V

PROJECT IV: A PILOT TEST OF AN INTERVENTION BASED ON THE HEALTH BELIEF MODEL TO IMPROVE ATTITUDES TOWARDS INJURY PREVENTION AND FUNCTIONAL PERFORMANCE

Introduction

Lower extremity musculoskeletal injuries are prevalent among the physically active population.[1-3] They account for over 50% of all collegiate and recreational athletic injuries.[1,2,47] The immediate negative impacts of these injuries include functional deficits, economic burden, and potential psychological effects.[7,65] In addition to the immediate impacts, there are several long-term consequences associated with these injuries including a decreased health-related quality of life, early development of post-traumatic osteoarthritis, and economic burden.[4,5,34,66,67] Due to the negative impact these injuries impose on the individual and the health care system, there has been a growing paradigm shift towards injury prevention in sports medicine.

Exercise-related injury prevention programs (ERIPPs) were developed to reduce the occurrence of musculoskeletal injuries which occur due to participation in physical activity. Several ERIPPs have focused on the prevention of common lower extremity injuries such as ankle sprains, knee injuries, and hamstring strains.[10] These programs typically consist of exercises aimed to improve balance, strength, agility, and range of motion.[68] A number of studies have found ERIPPs to be effective at reducing the risk of lower extremity injuries.[10,32,68] Additionally, participation in ERIPPs has led to improvements in functional performance including strength, speed, balance, and agility.[62,63,69,70] However, the effectiveness of these programs are often limited by the compliance of the users to participate for the recommended

frequency and duration of the program.[11,70] Therefore, investigation into the reasons for low compliance with ERIPPs is warranted.

Several studies have investigated attitudes and perceptions towards ERIPPs using theory to guide the development of the scales.[27-29] Within female high school athletes, the most important behavioral determinants of ERIPP participation were perceived benefits and social influence from the Theory of Planned Behavior (TPB).[42] The participants were most interested in data to support the reduction of risk factors for lower extremity injury after participating in an ERIPP. Additionally, within male football players, the most important behavioral determinant of ERIPP participation was perceived benefits from the Health Belief Model (HBM).[28] Some of the potential benefits they perceived were a decrease in lower extremity injuries and an improvement in athletic performance.[28] The use of theory has led to a better understanding of some of the factors that may need to be targeted within the design of implementation strategies.

A previous study utilized an educational intervention to improve attitudes towards ERIPP participation and adoption of ERIPPs.[19] The educational intervention included information on the anatomy of the anterior cruciate ligament (ACL) and other pertinent knee structures, risk factors associated with ACL injury, and prevention techniques for ACL injury.[19] Participants were also instructed on how to perform prevention techniques and researchers provided feedback to ensure the exercises were completed properly. The athletes' attitudes towards ERIPPs improved following the intervention, however the improvement was not statistically significant. Additionally, the participation rate in ERIPPs did not significantly improve following the intervention.[19] The results of this study indicate that the educational intervention led to small improvements in attitudes towards ERIPP participation, but was not able to improve compliance

rates. There is a potential that grounding the intervention in theory may elevate the results from an improvement in attitudes to an improvement in compliance.

Using theory to guide the design of an intervention to improve attitudes towards ERIPPs may lead to improvements in the adoption and compliance rates of users. The HBM contains six constructs that are thought to directly predict participation in a preventative health behavior (perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy). One strategy that may be used to improve the behavioral determinants of ERIPP participation would be targeting each of these constructs through an intervention. An educational intervention could be used to provide the user with information regarding their susceptibility to injury, the potential consequences and severity of those injuries, the benefits of participating in an ERIPP, barriers to implementing an ERPP, and strategies to overcome those barriers. A lower extremity injury screening session could be used to assess the user for potential risk factors of lower extremity injuries. The results of the screening could be presented to the participant serving as a cue to action. Lastly, a demonstration of the ERIPP followed by participation in the ERIPP could be used to target self-efficacy. Using theory to inform the development of an implementation intervention may lead to improvements in attitudes towards ERIPP participation.

Previous literature has not investigated the use of an intervention guided by a theoretical model to improve behavioral determinants of ERIPP participation within users. There is a possibility that using theory to guide the design of the intervention will improve behavioral determinants of ERIPP participation. Therefore, the primary purpose of this study was to determine if an intervention based on the HBM could improve behavioral determinants of ERIPP participation. A secondary purpose was to examine whether an intervention based on the HBM

could lead to changes in functional performance within collegiate club sport participants. We hypothesized the intervention based on the HBM would lead to improvements in the behavioral determinants of ERIPP participation. Additionally, we hypothesized the intervention based on the HBM would lead to improvements in functional performance.

Methods

Study Design

This study utilized a repeated-measures design. Data was collected at three time points: pre-test, post-test, and follow-up. The pre-test occurred immediately before the intervention. The post-test occurred approximately 2 weeks after the intervention and follow-up occurred approximately 6 weeks following the intervention. The Health Belief Model Scale (HBMS) and Theory of Planned Behavior Scale (TPBS) were completed at all three time points. The lower extremity injury screening contained the Y-Balance Test (YBT) and Landing Error Scoring System-Real Time (LESS-RT) which were measured at the pre-test and follow-up measure. The independent variable was time and the dependent variables were scores on the HBMS, TPBS, YBT, and LESS-RT.

Participants

Members from the club sport men's rugby (n=12), women's rugby (n=11), and women's volleyball (n=8) teams of a large public university volunteered to participate in this study (Table V.1). Participants were recruited through club sport team meetings and emails sent to the coaches and/or club sport president. All participants were between the ages of 18-35 and reported being physically active. Physically active was defined as participating in a moderate level of exercise ≥90 minutes per week. Participants were excluded if they had a current injury or illness that prevented them from participating in the lower extremity injury screening, were already

participating in an ERIPP, or discontinued participation in club sport activities. Participants provided written informed consent prior to engaging in any research activities.

Procedures

Participants completed a demographic form which included variables such as gender, lower extremity injury history, and previous experience with ERIPPs. Then, the participants completed the HBMS, TPBS, and modified Disablement of the Physically Active Scale (mDPA). Once all surveys were complete, participants began the intervention. The first segment of the intervention included educational material and the demonstration of the 11+ ERIPP. Next, the participants completed lower extremity injury screening assessments which included the YBT and LESS-RT. Participants received the results of the lower extremity injury screening session from the primary investigator within one week of the intervention. This feedback regarding potential risk of injury was meant to serve as a cue to action for the participants. The investigators recommended that the participants completed the 11+ at least twice per week for the entirety of the study. Compliance was recorded by athletic training staff or club sport presidents throughout the duration of the intervention period. Two weeks following the pre-test and intervention, participants completed post-test measures which included the mDPA, HBMS and TPBS. Approximately 6 weeks following the intervention, participants completed the follow-up measures which included the mDPA, HBMS, TPBS, YBT, and LESS-RT.

Disablement of the Physically Active Scale

The modified Disablement in the Physically Active Scale (mDPA)[49] assesses the mental and physical components of disablement and the overall self-reported function of the participant. This measure was utilized to classify levels of physical and mental function in relation to participation in physical activity for the participants. The mDPA contains two subscales:

physical summary component (DPA-PSC) and mental summary component (DPA-MSC). The DPA-PSC contains 12 items used to assess physical functional impairment while the DPA-MSC contains 4 items to assess mental impairment related to physical activity. The response options range from no problem (0) to severe (4). Total scores are summed for each subscale. Higher scores on each subscale are associated with increased physical or mental impairment related to physical activity. The subscales of the mDPA have excellent internal consistencies ranging from 0.88-0.94.[49] Additionally, construct validity was established as the mDPA scores were strongly correlated to the original DPA.[49]

Health Belief Model Scale

The HBMS used the 6 constructs of the Health Belief Model to assess the behavioral determinants of ERIPP participation. The scale consisted of 9 subscales (Table V.2) and 39 items. The response options ranged along a 7-point Likert scale from strongly agree (3) to strongly disagree (-3). Positive responses for perceived susceptibility, perceived consequences, fear of injury, perceived benefits, community led self-efficacy, individual self-efficacy, general health cues, and external health cues would be associated with an increased likelihood to participate in an ERIPP while positive responses for perceived barriers would be associated with a decreased likelihood to participate in an ERIPP. The HBMS has been used to assess behavioral determinants of ERIPP participation within a physically active population. The internal consistencies for the subscales were found to be acceptable (0.80-0.95).

Theory of Planned Behavior Scale

The TPBS uses the 3 constructs of the Theory of Planned Behavior as well as intention to participate in an ERIPP to predict participation in an ERIPP. The TPBS contained 5 subscales (Table V.2) and 20 items to assess the behavioral determinants of ERIPP participation. The

response options ranged along a 7-point Likert scale from strongly agree (3) to strongly disagree. Positive responses for perceived benefits, perceived social norms, perceived social influence, and intention to participate would be associated with an increased likelihood to participate in an ERIPP while positive responses for perceived barriers would be associated with a decreased likelihood to participate. The TPBS has been used within a physically active population to assess behavioral determinants of ERIPP participation. The internal consistencies of the subscales were found to be acceptable (0.77-0.87).

Interventions

Each part of the intervention was aimed at specific constructs of the HBM. The educational intervention provided information which targeted the perceived susceptibility, perceived severity, perceived benefits, and perceived barriers constructs. The individualized feedback from the lower extremity injury screening assessments were meant to serve as a cue to action for the participants. Demonstration and participation in the 11+ ERIPP was aimed at the self-efficacy construct.

Educational Intervention

The educational aspect of the intervention was a three-part program delivered using infographics that were orally presented by the primary investigator in small group settings. This aspect of the intervention targeted the perceived susceptibility, perceived severity, perceived benefits, and perceived barriers constructs of the HBM. Infographics were selected over other forms of media to make the information easily accessible and visually engaging. The objectives of Part 1 were to describe ERIPPs, the benefits and barriers of participating in ERIPPs, and strategies to overcome the barriers. The objectives of Part 2 were to define ankle sprain injuries, explain the risk of sustaining an ankle sprain, describe the negative consequences of ankle

sprains, and provide techniques to prevent injuries to the ankle joint. The objectives of Part 3 were to describe ACL tears, explain the risk of sustaining an ACL tear, describe the negative consequences associated with ACL tears, and provide techniques to prevent injuries to the knee joint. The primary investigator led the participants through the infographics in-person and provided answers to any questions from the participants. Color copies of each of the infographics were provided to the participants to reference at any point throughout the study.

Injury Prevention Program Demonstration

The 11+ has been able to reduce the occurrence of multiple types of lower extremity injuries such as ACL tears, hamstring strains, and lateral ankle sprains.[64,68,71] Additionally, the 11+ has been able to improve strength, balance, and functional performance within physically active individuals.[69,70,72] The program is cost-effective to implement and requires very little equipment to complete the exercises. Additionally, the movements utilized within the 11+ were similar to functional movements which would occur within volleyball and rugby activities.

The 11+ is a 3-part program which is completed as a warm-up prior to physical activity. The first part of the program consists of 8 minutes of running exercises. The second part includes strength, plyometrics, and balance exercises lasting approximately 10 minutes. The final part includes 2 minutes of running warm-up drills. The entire program takes approximately 20 minutes to complete.[64] It is recommended to complete the 11+ at least twice per week, prior to physical activity. All participants received a copy of the 11+ injury prevention program which included brief descriptions and pictures of each exercise.[64] The exercises within the 11+ were explained and demonstrated for the participants by the club sport athletic trainers. Additional time was allowed for the participants to practice the exercises and ask questions regarding the program.

Compliance was tracked and recorded by either the athletic trainer or club sport president each time the team participated in the 11+. The follow-up period was 6 weeks long, therefore 100% compliance would be achieved by participating in the 11+ a total of 12 times during the follow-up period. The total number of times a participant completed the 11+ was divided by 12 and transformed into a percentage.

Lower Extremity Injury Screening Risk

The YBT was used to measure dynamic balance and has previously been determined to have good intrarater (ICC=0.85-0.91) and interrater (ICC=0.99) reliability.[73] This assessment was selected because lower scores on the anterior reach of the YBT, as well as asymmetries between limbs, have been associated with the occurrence of lower extremity injuries.[74-76] Participants performed the YBT on each limb while barefoot. The participants balanced on one limb on the center box of the YBT instrument and reached maximally into the anterior direction.[73] The participants were instructed to push the box along the red portion and to not place excessive weight on the push box.[73] Participants completed four practice trials immediately followed by three testing trials for each limb.[76] Participants were given feedback when an error occurred during the practice trials and repeated the trial if the error occurred within the testing trials. Errors included removing the hands from the hips,[75] losing balance, heel coming off the stance board, placing too much weight on the push board, and slinging the push board forward.[76] The average of the three scores was normalized to leg length which was measured from the anterior superior iliac spine to the most distal portion of the medial malleolus. The right and left limb were then averaged for analyses purposes.

The LESS-RT was used to assess landing technique and has previously been determined to have good interrater reliability (ICC=0.72-0.81).[77] The LESS-RT was selected because of its

use in identifying improper landing technique[78] as well as the ability of the task to identify changes in performance after the introduction of an ERIPP.[79] To complete the LESS-RT, participants jumped off a 30-cm box to a marked spot half of their height away from the box and then immediately jumped straight up into the air.[77] Two practice jumps were immediately followed by four testing jumps. The first two testing jumps were viewed from the frontal plane and the second two were viewed from the sagittal plane. The investigator evaluated the participants' landing technique using a previously developed rating form.[77] While the first jump was performed, the rater evaluated stance width, foot position when landing, and initial foot contact. Maximum knee valgus and the amount of lateral trunk flexion were observed during the second jump. During the third jump, the evaluator observed the initial landing of the feet and the amount of knee flexion displacement. The amount of trunk flexion displacement was evaluated during the fourth and final jump. The type of landing and overall impression was rated by the evaluator once all the jumps were completed.[77] Errors were summed to create a total score.

All raters were athletic trainers with a minimum of one year of clinical experience. Standardized operating procedures were utilized to administer all tests to ensure uniformity in the procedures. The data was entered into a spreadsheet which generated an individualized report for each participant detailing their results on each assessment compared to normative values or previously identified injury risk cut-off scores reported in the literature through color coded graphs (Figure V.1). Additionally, the 11+ exercises which could aid in improving performance on the YBT and LESS-RT were identified. Participants were given a copy of the report and the primary investigator reviewed the results with all participants and answered related questions.

Data Analysis

Total scores for each subscale of the HBMS and TPBS were calculated and used for analysis. To determine if the intervention was able to improve behavioral determinants of ERIPP participation, separate repeated-measures ANOVAs were used for each subscale of the HBMS and TPBS. Pre-test scores were compared to the post-test and follow-up scores. To determine if the intervention and participation in the 11+ was able to improve functional performance on the YBT and LESS-RT, a separate repeated-measures ANOVA was used to compare performance at the pre-test and follow-up measure ($P<0.05$). Partial eta squared was used to determine the magnitude of change in the variable of interest between measurement time points (pre-test vs post-test, pre-test vs follow-up). Effect sizes were interpreted as small ($0.06>\eta^2\geq0.01$), moderate ($0.14>\eta^2\geq0.07$), or large ($\eta^2\geq0.15$).[80]

Results

Thirty-one participants completed the pre-test, twenty-two participants completed the post-test, and twenty-one participants completed the follow-up measure. Five participants discontinued participation in club sports after the pre-test and were excluded from analyses due to incomplete data. The overall average compliance with the 11+ throughout the duration of the study was 44.23±19.12%.

The descriptive statistics for the subscales of the HBMS and TPBS, YBT reach distances, and LESS-RT scores at the pre-test, post-test, and follow-up, as well as comparison statistics between the pre-test and post-test and pre-test and follow-up can be found within Table V.3. There was a large statistically significant improvement in HBMS individual self-efficacy from the pre-test to post-test and pre-test to the follow-up measure. Additionally, there was a large statistically significant improvement in HBMS community led self-efficacy from the pre-test to

the post-test measure and from the pre-test to the follow-up measure. No other significant differences in HBMS and TPBS subscales were identified (P>0.05). There was a large statistically significant improvement in LESS-RT scores from the pre-test to the follow-up measure. There were no statistically significant differences in the anterior reach of the YBT from the pre-test to follow-up measure (p>0.05).

Discussion

The main finding of this study was the HBM-based intervention yielded improvements in community led self-efficacy, individual self-efficacy, and LESS-RT scores within club sport athletes. Community led self-efficacy improved from “somewhat agree” to “agree”. Individual self-efficacy improved from “neither agree nor disagree” to “agree”. LESS-RT scores also improved by a reduction in 1 error at the follow-up. Therefore, the HBM-based intervention which included education, injury screening, and the 11+ program led to improvements in attitudes towards ERIPP participation and functional performance.

Only one study has used an intervention to improve the attitudes of the users of the ERIPP and the results of the study aligned well with the results of the present study. The study utilized an educational intervention paired with a demonstration of preventative exercises to improve users’ attitudes towards ERIPPs and participation rates.[19] The educational portion contained information on the anatomy of the ACL and other pertinent knee structures, risk factors associated with ACL injury, and prevention techniques for ACL injury. Improvements in attitudes were identified, but the improvements were not statistically significant. Additionally, there were no significant improvements in participation rates after the intervention. Within the present study, improvements in individual self-efficacy and community led self-efficacy were noted after the introduction of the intervention. The intervention used within this study showed

promise for improving behavioral determinants of ERIPP participation, but there remain areas for improvement in the effectiveness of the intervention due to the lack of improvements in the remaining behavioral determinants of ERIPP participation.

We hypothesized that participating in the intervention would lead to improvements in functional performance. Our hypothesis was confirmed through decreases in LESS-RT scores over time. Our findings are supported by O'Malley et al.[81] and Distefano et al.[82] who identified significant improvements in the LESS after participation in an ERIPP. O'Malley et al.[81] utilized an ERIPP that was performed as a warm-up to activity and found the ERIPP led to an average reduction of 2.5 errors in the group that participated in the ERIPP. Distefano et al.[82] utilized a standard warm-up and dynamic integrated movement enhancement program and found improvements in LESS scores with both programs. One important factor when determining if the changes in LESS-RT scores are clinically meaningful is minimum detectable change (MDC). MDC is the amount of change that must occur to be considered change that is not due to measurement error. The MDC was previously reported for the LESS to be 1.16 or the reduction in at least one error.[79] The improvements found within this study were 1.26 which marginally exceeds the MDC for this test. A total of 11 (58%) participants within the study improved in LESS-RT scores by the reduction of at least 1 error. An additional factor to consider when determining if the change in performance is clinically meaningful is cutoff scores for the measure. Cutoff scores are used to separate those who are at risk for injury from those who are not. A cutoff score has previously been reported as 5 errors for the LESS-RT.[78] Therefore, those who have more than 5 errors are at an increased risk of injury. In our study, 4 (21%) of the participants improved from a score $\geq$5 errors to a score < 5 errors. The intervention was able to significantly improve jump landing performance.

The lack of change in performance on the anterior reach of the YBT did not align with our hypothesis that participation in the intervention would lead to improvements in functional performance. In addition to the average anterior score, asymmetry between limbs did not significantly change after the intervention. Previous literature has indicated an asymmetry between limbs greater than 4cm is associated with an increased risk of lower extremity injury.[76] A total of 4 participants had an asymmetry ≥4cm between limbs at the pre-measure while a total of 3 participants had an asymmetry ≥4cm at the follow-up measure. The low number of individuals falling into the at-risk category may indicate there was limited room for improvement. Additionally, there is evidence that YBT performance remains unchanged during participation in a competitive season.[83] Conversely, Steffen et al.[70] found improvements in balance and star excursion balance test performance post participation in the 11+ for approximately 10 weeks. An additional study found improvements in functional performance including strength, speed, balance, and agility after approximately 12 weeks of participation in the 11+.[69] Within our study, the participants only completed the 11+ for 6 weeks. Future research should investigate changes in functional performance after participation in an ERIPP for a variety of durations to identify the most beneficial duration of participation.

The intervention utilized in this study was able to increase individual self-efficacy and community led self-efficacy which are two important behavioral determinants of ERIPP participation. However, the intervention was not successful at improving several of the other behavioral determinants. Additionally, the compliance rate was approximately 44%. Therefore, the HBM based intervention was able to improve some behavioral determinants of ERIPP participation and functional performance, but participation rates remained limited. There is a potential that an intervention designed specifically for the individual based on their responses on

the HBMS and TPBS could be more effective at improving behavioral determinants of ERIPP participation and compliance with the program. For example, the HBMS and TPBS could be completed by a physically active population that is at risk for lower extremity injury where participation in an ERIPP. The clinician would then evaluate the responses on the scales and determine which behavioral determinants were most associated with intention to participate for each individual. The intervention would then be customized to meet the factors which may motivate each individual participant or a majority of the group. If perceived benefits and barriers were the most important aspects for the individual, the intervention would focus on providing support for the benefits of the ERIPP and giving the individual many strategies to overcome the barriers. A more customized approach to implementation strategies may need to be utilized to improve adoption and compliance of ERIPP participation.

Limitations

There were several limitations associated with this study. First, due to the exploratory nature of this study, the sample size was small and potentially insufficient to identify changes in all aspects of behavioral determinants after the intervention. Future research should utilize a larger sample size to determine if changes within the other subscales occur due to an intervention. The participants in the study were recruited from one university and from three specific club sport teams. The results of the study may not be generalizable to other physically active populations. Future research should investigate the effects of this intervention within a more diverse physically active population. An additional limitation of this study was lower extremity injury occurrence was not tracked during the follow-up period. There is a potential that lower extremity injury could influence the behavioral determinants of ERIPP participation and performance on the lower extremity injury screening tests. Future research should include lower

extremity injury tracking within the study design and consider the potential for injury occurrence to be a confounding variable. Additionally, participants only completed the 11+ for 6 weeks which was a limitation of the duration of the club sport season. Future studies should investigate the effectiveness of the intervention to improve functional performance after a longer duration of participation.

Conclusion

Following a HBM-based intervention, improvements in attitudes and functional performance were found within club sport participants. Specifically, community led self-efficacy and individual self-efficacy improved after the intervention indicating the individuals had more confidence in their ability to participate in an ERIPP. Additionally, the participants showed an improvement in LESS-RT scores by an average reduction of one error. The initial results of the implementation of the intervention are promising, however there were not improvements in all of the behavioral determinants of ERIPP participation and compliance remained low. Future research should focus on the development of individual tailored interventions to improve attitudes towards ERIPPs and compliance rates.

Table V.1. Participant Demographics

Sport	Age (years)	Height (cm)	Mass (kg)	Previous Exposure to ERIPP	Previous history of injury
Men's Rugby (n=12)	20.00±1.90	180.80±3.91	84.57±11.71	3	9
Women's Rugby (n=11)	19.55±2.07	162.44±7.59	71.81±11.66	1	7
Women's Volleyball (n=8)	19.63±1.77	171.77±8.79	67.82±13.15	4	7

Table V.2. Definitions of Subscales of the Health Belief Model Scale and Theory of Planned Behavior Scale

HBMS Subscale	Definition
Perceived Susceptibility	The participant's perception related to the likelihood that they would suffer a lower extremity injury
Fear of Injury	The participant's level of fear related to lower extremity injury occurrence
Perceived Consequences	The participant's perceptions of the short-term and long-term consequences that may occur as a result of a lower extremity injury
Perceived Benefits	The participant's perception of the potential benefits of participating in an injury prevention program
Perceived Barriers	The participant's perception of the potential barriers that may prevent them from participating in an injury prevention program
Individual Self-Efficacy	The participant's beliefs regarding their ability to participate in an injury prevention program as an individual
Community led Self-Efficacy	The participant's beliefs regarding their ability to participate in an injury prevention program if it was led by a community
General Health Cues	The participant's beliefs regarding maintenance of general health and participating in preventative health behaviors
External Health Cues	The participant's beliefs regarding reminders from external sources to participate in an injury prevention program (Ex. Coach, physician, athletic trainer)
TPBS Subscale	**Definition**
Perceived Benefits	The participant's perception of the potential benefits of participating in an injury prevention program
Perceived Barriers	The participant's perception of the potential barriers that may prevent them from participating in an injury prevention program
Perceived Social Norms	The influence of the beliefs regarding injury prevention program participation of the important individuals to the participant (Ex. Parents, friends, teammates, coach)
Perceived Social Influence	The influence of individuals around the participant including whether most of the individuals participate in an injury prevention program and whether the injury prevention program is supported by evidence.
Intention to Participate	The participants beliefs regarding whether they would be likely or unlikely to participate in an injury prevention program

HBMS=Health Belief Model Scale
TPBS=Theory of Planned Behavior Scale

Table V.3. Comparison of Pre-Test to Post Test and Pre-Test to Follow-Up Scores

			Pre-Test vs Post-Test				Pre-Test vs Follow-Up		
Variable	Pre-Test	Post-Test	F	P-Value	Partial Eta Squared	Follow-Up	F	P-value	Partial Eta Squared
TPBS Perceived Benefits	11.20±4.23	11.07±4.92	0.40	0.53	0.02	10.53±5.17	0.05	0.83	0.003
TPBS Perceived Barriers	0.80±5.10	1.13±4.37	1.17	0.29	0.05	2.00±4.21	0.06	0.81	0.003
TPBS Social Norms	7.60±4.40	8.33±4.53	1.55	0.23	0.07^	8.60±3.48	0.08	0.78	0.004
TPBS Social Influence	7.00±2.45	6.87±2.85	0.29	0.60	0.01	7.33±1.88	0.12	0.73	0.006
TPBS Intention	9.80±5.03	10.53±5.14	0.48	0.50	0.02	11.33±4.01	1.69	0.21	0.08^
HBMS Perceived Susceptibility	1.67±5.12	-1.67±6.21	2.78	0.11	0.12^	-0.13±6.64	1.58	0.22	0.07^
HBMS Fear of Injury	-1.24±3.75	-0.87±4.14	0.66	0.43	0.03	-0.60±4.64	0.31	0.59	0.02
HBMS Perceived Consequences	-3.16±5.40	-2.60±8.48	0.32	0.58	0.02	-2.80±6.94	0.54	0.47	0.03
HBMS Perceived Benefits	8.60±5.77	8.73±5.79	0.86	0.37	0.04	9.33±5.16	0.59	0.45	0.03
HBMS Perceived Barriers	-1.41±5.41	0.66±7.07	3.44	0.08	0.14!	0.07±5.44	1.29	0.27	0.06^
HBMS Individual Self-Efficacy	0.73±4.48	2.93±4.30	4.55	0.05*	0.18!	3.20±3.49	4.92	0.04*	0.20!
HBMS Community led Self-Efficacy	4.40±2.75	6.07±3.43	6.72	0.02*	0.24!	7.07±2.05	15.55	0.001*	0.44!
HBMS General Health Cues	11.73±6.18	12.93±5.27	2.41	0.14	0.10^	11.87±5.04	0.002	0.97	0.00
HBMS External Health Cues	2.80±2.62	2.67±2.61	0.83	0.37	0.04	3.00±2.14	0.45	0.51	0.02
YBT Anterior Reach	60.72±6.43	-	-	-	-	59.11±6.03	3.49	0.08	0.16!
LESS-RT	6.53±2.46	-	-	-	-	5.27±1.94	6.83	<0.001*	0.28!

HBMS=Health Belief Model Scale, TPBS=Theory of Planned Behavior Scale, YBT=Y-Balance Test, LESS-RT=Landing Error Scoring System-Real Time

*=Significance at P<0.05

^ =moderate effect size

! =large effect size

Figure V.1. Sample Participant Report for Lower Extremity Injury Screening

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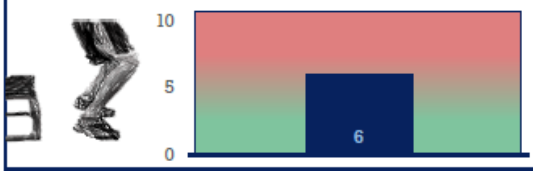
Injury Screening Evaluation Report 2/15/2018

Participant:	SAMPLE	Date of Collection:	09/25/2017
Institution:	ODU	Prepared By:	EMH

Landing Error Scoring System



You have below average landing technique.

Landing technique is derived from many different parts and functions of the body.

You could focus on the following exercises from the 11+ program to improve your landing technique:

8 SIDEWAYS BENCH
STATIC

Starting position: Lie on your side with the knee of your lowermost leg bent to 90 degrees. Support your upper body by resting on your forearm and knee. The elbow of your supporting arm should be directly under your shoulder.
Exercise: Lift your uppermost leg and hips until your shoulder, hip and knee are in a straight line. Hold the position for 20-30 sec. Take a short break, change sides and repeat. **3 sets on each side.**

To progress: See exercise 8 levels 2 & 3 from the 11+

9 HAMSTRINGS
BEGINNER

Starting position: Kneel on a soft surface. Ask your partner to hold your ankles down firmly.
Exercise: Your body should be completely straight from the shoulder to the knee throughout the exercise. Lean forward as far as you can, controlling the movement with your hamstrings and your gluteal muscles. When you can no longer hold the position, gently take your weight on your hands, falling into a push-up position.

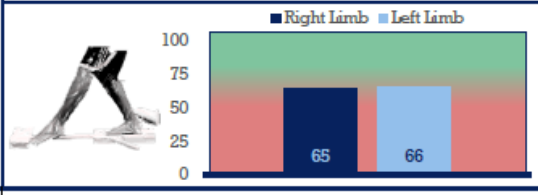
To progress: See exercise 9 levels 2 & 3 from the 11+

12 JUMPING
VERTICAL JUMPS

Starting position: Stand with your feet hip-width apart. Place your hands on your hips if you like.
Exercise: Imagine that you are about to sit down on a chair. Bend your legs slowly until your knees are flexed to approx 90 degrees, and hold for 2 sec. Do not let your knees buckle inwards. From the squat position, jump up as high as you can. Land softly on the balls of your feet with your hips and knees slightly bent. Repeat the exercise for 30 sec. **2 sets.**

To progress: See exercises 12 levels 2 & 3 from the 11+

Y-Balance - Anterior



Right: You have below average anterior reach.
Left: You have below average anterior reach.

The anterior reach requires ankle dorsiflexion range of motion, balance, and quadriceps strength.

You could focus on the following exercises from the 11+ program to improve your landing technique:

7 THE BENCH
STATIC

Starting position: Lie on your front, supporting yourself on your forearms and feet. Your elbows should be directly under your shoulders.
Exercise: Lift your body up, supported on your forearms, pull your stomach in, and hold the position for 20-30 sec. Your body should be in a straight line. Try not to sway or arch your back. **3 sets.**

To progress: See exercise 7 levels 2 & 3 from the 11+

10 SINGLE-LEG STANCE
HOLD THE BALL

Starting position: Stand on one leg.
Exercise: Balance on one leg whilst holding the ball with both hands. Keep your body weight on the ball of your foot. Remember: try not to let your knees buckle inwards. Hold for 30 sec. Change legs and repeat. The exercise can be made more difficult by passing the ball around your waist and/or under your other knee.
2 sets.

To progress: See exercise 10 levels 2 & 3 from the 11+

11 SQUATS
WITH TOE RAISE

Starting position: Stand with your feet hip-width apart. Place your hands on your hips if you like.
Exercise: Imagine that you are about to sit down on a chair. Perform squats by bending your hips and knees to 90 degrees. Do not let your knees buckle inwards. Descend slowly then straighten up more quickly. When your legs are completely straight, stand up on your toes then slowly lower down again. Repeat the exercise for 30 sec. **2 sets.**

To progress: See exercises 11 levels 2 & 3 from the 11+

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CHAPTER VI

CONCLUSIONS

The overall purpose of this dissertation was to better understand factors related to low compliance with exercise-related injury prevention programs (ERIPPs) and explore strategies to improve attitudes towards ERIPPs. The overall purpose of this dissertation was accomplished through a series of studies. The first study was a systematic review to assess which behavioral or social theoretical models or frameworks had been used within research related to ERIPPs and to assess the extent in which those models or frameworks were used within the research. The second study evaluated the potential use of the Health Belief Model (HBM) and Theory of Planned Behavior (TPB) within ERIPP research. The third study designed scales based on the HBM and TPB to assess the behavioral determinants of ERIPP participation and piloted those scales within a physically active population. The fourth study evaluated the psychometric properties of the HBM and TPB scales within a physically active population. Lastly, the final study evaluated the effectiveness of an intervention based on the HBM to change the behavioral determinants of ERIPP participation and functional performance within club sport participants. To provide a succinct summary of the results within this dissertation, the hypotheses from chapter I are revisited:

Hypothesis for Aim 1: The HBM and TPB scales will have acceptable internal consistency within a population of physically active adults.

Findings: The hypothesis was confirmed as a majority of the subscales of the HBM and TPB scales had acceptable internal consistency (0.70-0.90). However, the HBM perceived severity, TPB attitudes, and TPB intention to participate fell below acceptable internal consistency (<0.70).

Hypothesis for Aim 2 (A): The structures of the HBMS and TPBS will identify the constructs associated with those models.

Findings: The hypothesis was confirmed and the subscales formed through the factor analysis aligned well with the constructs of the HBM and TPB. Nine factors were identified within the HBM scale including perceived susceptibility, fear of injury, perceived consequences, perceived benefits, perceived barriers, individual self-efficacy, community led self-efficacy, general health cues, and external health cues. Five factors were identified within the TPB scale including perceived benefits, perceived barriers, perceived social norms, perceived social influence, and intention to participate.

Hypothesis for Aim 2 (B): The subscales formed within the HBMS and TPBS will have acceptable internal consistency.

Findings: The hypothesis was confirmed and the subscales of the HBM and TPB scales all had acceptable internal consistencies (0.77-0.95) within a physically active population.

Hypothesis for Aim 3 (A): Behavioral determinants towards ERIPP participation will be more positive following the intervention.

Findings: The hypothesis was partially confirmed with statistically significant improvements in individual and community led self-efficacy following an intervention based on the HBM.

Hypothesis for Aim 4: Functional performance will improve following an intervention based on the HBM.

Findings: The hypothesis was confirmed with a statistically significant improvement in performance on the LESS-RT following the intervention based on the HBM. However, there were no statistically significant improvements in the anterior reach of the YBT.

Summary and Clinical Application

The reviews of the literature within this dissertation (Project IA, IB) provided a synthesis of the findings related to the use of theory within ERIPP related research. Project IA identified the HBM and TPB to be the most commonly used social or behavioral theories within ERIPP related research. Additionally, the use of theory within the available literature was mainly level B meaning a social or behavioral construct was measured, but the theory was not tested. Only two articles fell in the level C category meaning the social or behavioral theory was tested. The results of the literature review indicated an increase in use of social or behavioral theories within ERIPP research as well as a higher level of use than previously described in the systematic review by McGlashan et al.[16] Project II identified how the HBM and TPB could be used to better understand low compliance with ERIPPs. The project identified the need for the development of scales directly based on the HBM and TPB to assess behavioral determinants of ERIPP participation.

Project IB identified the need for the development of scales based on the HBM and TPB to assess behavioral determinants of ERIPP participation. Therefore, the purpose of Project II was to design scales based on the HBM and TPB and pilot the scales within physically active adults. Our hypothesis was confirmed with most of the subscales of the HBM and TPB scales having acceptable internal consistencies. However, a few of the subscales fell a little short of acceptable internal consistency. The results of Project II revealed the promise of the HBM and TPB scales, but identified there was a need for further analysis of the psychometric properties within a larger physically active population.

Project III was designed to further evaluate the HBM and TPB scales within a physically active population. The scales were modified to allow for more response choices and distributed to a larger, more diverse population. The first purpose of the study was to identify the factors

within each scale and determine whether they aligned with the constructs of the two theories. Our hypothesis was confirmed and the factors that were identified aligned well with the constructs of the HBM and TPB. The secondary purpose was to further examine the psychometric properties of the two scales. Our hypothesis was confirmed and all of the subscales of had acceptable internal consistency. Project III confirmed the psychometric properties of the HBM and TPB scales.

Project IV was designed to determine if an intervention based on the HBM could improve the behavioral determinants of ERIPP participation and functional performance. The intervention specifically addressed each of the constructs of the HBM. Statistically significant improvements were found in individual and community led self-efficacy after the intervention based on the HBM. Additionally, statistically significant improvements on the LESS-RT were found after participation in the intervention. These results were promising for the effectiveness of an intervention based on the HBM. However, there was room for improvement in the other subscales of the HBM and TPB as well as compliance rates.

Project IV showed promise for an intervention based on the HBM to improve attitudes towards ERIPP participation. The project also brought to light the potential for using the responses on the HBM and TPB scales to specifically design the intervention for an individual. Potentially using the scales to first assess the behavioral determinants which were most important to each individual and then formulating an intervention based on those behavioral determinants would lead to more significant improvements in attitudes and compliance. Future research should investigate the effectiveness of tailored interventions based on behavioral determinants of ERIPP participation to improve attitudes towards ERIPP participation. Additionally, future research should investigate whether differences in behavioral determinants

of ERIPP participation exist between individuals with different demographic variables such as gender, participation level, previous history of injury, or previous exposure to ERIPPs. There is a potential that interventions could be designed for groups of individuals who fit into these demographic variables based on the most important behavioral determinants of ERIPP participation to those users.

REFERENCES

1. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *J Athl Train.* 2007;42(2):311-319.
2. Roos KG, Kerr ZY, Mauntel TC, Djoko A, Dompier TP, Wickstrom EA. The Epidemiology of Lateral Ligament Complex Ankle Sprains in National Collegiate Athletic Association Sports. *Am J Sports Med.* 2016.
3. Nelson AJ, Collins CL, Yard EE, Fields SK, Comstock RD. Ankle Injuries Among United States High School Sports Athletes, 2005-2006. *J Athl Train.* 2007;42(3):381-387.
4. Houston MN, Van Lunen BL, Hoch MC. Health-Related Quality of Life in Individuals With Chronic Ankle Instability. *J Athl Train.* 2014;49(6):758-763.
5. Lohmander LS, Östenberg A, Englund M, Roos H. High prevalence of knee osteoarthritis, pain, and functional limitations in female soccer players twelve years after anterior cruciate ligament injury. *Arthritis & Rheum.* 2004;50(10):3145-3152.
6. Shah S, Thomas AC, Noone JM, Blanchette CM, Wikstrom EA. Incidence and Cost of Ankle Sprains in United States Emergency Departments. *Sports Health.* 2016;8(6):547-552.
7. Knowles SB, Marshall SW, Miller T, et al. Cost of injuries from a prospective cohort study of North Carolina high school athletes. *Inj Prev.* 2007;13(6):416-421.
8. Lubowitz JH, Appleby D, Lubowitz JH, Appleby D. Cost-effectiveness analysis of the most common orthopaedic surgery procedures: knee arthroscopy and knee anterior cruciate ligament reconstruction. *Arthroscopy.* 2011;27(10):1317-1322.
9. Mather 3rd RC, Koenig L, Kocher MS, et al. Societal and economic impact of anterior cruciate ligament tears. *J Bone Joint Surg Am.* 2013;95(19):1751-1759.

10. Hübscher M, Zech A, Pfeifer K, Hänsel F, Vogt L, Banzer W. Neuromuscular training for sports injury prevention: a systematic review. *Med Sci Sports Exerc.* 2010;42(3):413-421.

11. Sugimoto D, Myer GD, Bush HM, Klugman MF, McKeon JMM, Hewett TE. Compliance With Neuromuscular Training and Anterior Cruciate Ligament Injury Risk Reduction in Female Athletes: A Meta-Analysis. *J Athl Train.* 2012;47(6):714-723

12. Steffen K, Meeuwisse WH, Romiti M, et al. Evaluation of how different implementation strategies of an injury prevention programme (FIFA 11+) impact team adherence and injury risk in Canadian female youth football players: a cluster-randomised trial. *Br J Sports Med.* 2013;47(8):480-487.

13. Champion VL. Revised susceptibility, benefits, and barriers scale for mammography screening. *Res Nurs Health.* 1999;22(4):341-348.

14. Gerend MA, Shepherd JE. Predicting human papillomavirus vaccine uptake in young adult women: comparing the health belief model and theory of planned behavior. *Ann Behav Med.* 2012;44(2):171-180.

15. Lajunen T, Räsänen M. Can social psychological models be used to promote bicycle helmet use among teenagers? A comparison of the Health Belief Model, Theory of Planned Behavior and the Locus of Control. *J Safety Res.* 2004;35(1):115.

16. McGlashan AJ, Finch CF. The extent to which behavioural and social sciences theories and models are used in sport injury prevention research. *Sports Med.* 2010;40(10):841-858 818p.

17. Rosenstock IM, Strecher VJ, Becker MH. Social learning theory and the health belief model. *Health Educ Q.* 1988;15(2):175-183.

18. Ajzen I. From intentions to actions: A theory of planned behavior. In: Beckmann JKaJ, ed. *Action Control: From Cognition to Behavior*. Heidelberg, Germany: Springer-Verlag; 1985:11-39.

19. Iversen MD, Friden C. Pilot study of female high school basketball players' anterior cruciate ligament injury knowledge, attitudes, and practices. *Scand J Med Sci Sports.* 2009;19(4):595-602.

20. Frank BS, Register-Mihalik J, Padua DA. High levels of coach intent to integrate a ACL injury prevention program into training does not translate to effective implementation. *J Sci Med Sport.* 2015;18(4):400-406.

21. Fernandez WG, Yard EE, Comstock RD. Epidemiology of lower extremity injuries among U.S. high school athletes. *Acad Emerg Med.* 2007;14(7):641-645.

22. Glanz K, Rimer BK, Viswanath K. *Health behavior and health education : theory, research, and practice.* San Francisco, CA : Jossey-Bass, c2008.4th ed.; 2008.

23. Trifiletti LB, Gielen AC, Sleet DA, Hopkins K. Behavioral and Social Sciences Theories and Models: Are They Used in Unintentional Injury Prevention Research? *Health Educ Res.* 2005;20(3):298-307.

24. Hoch MC, Russell DM. Plantar cooling does not affect standing balance: A systematic review and meta-analysis. *Gait Posture.* 2016;43:1-8.

25. Quality Assessment Tool for Before-After (Pre-Post) Studies With No Control Group. 2014; https://www.nhlbi.nih.gov/health-pro/guidelines/in-develop/cardiovascular-risk-reduction/tools/before-after. Accessed 10/23/2017.

26. Chan DK, Hagger MS. Transcontextual development of motivation in sport injury prevention among elite athletes. *J Sport Exer Psychol.* 2012;34(5):661-682.

27. Finch CF, Doyle TLA, Dempsey AR, et al. What do community football players think about different exercise-training programmes? Implications for the delivery of lower limb injury prevention programmes. *Br J Sports Med.* 2014;48(8):702-707 706p.

28. Finch CF, White P, Twomey D, Ullah S. Implementing an exercise-training programme to prevent lower-limb injuries: considerations for the development of a randomised controlled trial intervention delivery plan. *Br J Sports Med.* 2011;45(10):791-796 796p.

29. White PE, Ullah S, Donaldson A, et al. Encouraging junior community netball players to learn correct safe landing technique. *J Sci Med Sport.* 2012;15(1):19-24.

30. Saunders N, Otago L, Romiti M, Donaldson A, White P, Finch C. Coaches' perspectives on implementing an evidence-informed injury prevention programme in junior community netball. *Br J Sports Med e.* 2010;44(15):1128-1132.

31. O'Brien J, Finch, M, Finch, C. Injury Prevention Exercise Programs for Professional Soccer: Understanding the Perceptions of the End-Users. *Clin J Sport Med.* 2016;0:1-9.

32. McGuine TA, Keene JS. Do proprioceptive training programmes reduce the risk of ankle sprains in athletes? *Int J Sports Med.* 2003;4(5):1-8.

33. McLeod TCV. The Effectiveness of Balance Training Programs on Reducing the Incidence of Ankle Sprains in Adolescent Athletes. *J Sport Rehabil.* 2008;17(3):316-323.

34. von Porat A, Roos EM, Roos H. High prevalence of osteoarthritis 14 years after an anterior cruciate ligament tear in male soccer players: a study of radiographic and patient relevant outcomes. *Br J Sports Med.* 2004;38(3):263-263.

35. Utting MR, Davies G, Newman JH. Is anterior knee pain a predisposing factor to patellofemoral osteoarthritis? *Knee.* 2005;12(5):362-365.

36. Herman K, Barton C, Malliaras P, Morrissey D. The effectiveness of neuromuscular warm-up strategies, that require no additional equipment, for preventing lower limb injuries during sports participation: a systematic review. *BMC Medicine.* 2012;10(1):75-75.

37. Threlfall AG, Meah S, Fischer AJ, Cookson R, Rutter H, Kelly MP. The appraisal of public health interventions: the use of theory. *J Public Health.* 2015;37(1):166-171.

38. Krieger N. Living and Dying at the Crossroads: Racism, Embodiment, and Why Theory Is Essential for a Public Health of Consequence. *Am J Public Health.* 2016;106(5):832-833.

39. Zhi-Juan C, Yue C, Shu-Mei W. Health belief model based evaluation of school health education programme for injury prevention among high school students in the community context. *BMC Public Health.* 2014;14(1):1-15.

40. Abraham C, Sheeran, P. The Health Belief Model. In: Norman MCP, ed. *Predicting Health Behaviour.* 2nd ed. New York, NY: Open University Press; 2005.

41. Ajzen I. Constructing a Theory of Planned Behavior Questionnaire. http://people.umass.edu/aizen/tpb.html. Accessed April 19, 2016, 2016.

42. Martinez JC, Mazerolle SM, Denegar CR, et al. Female adolescent athletes' attitudes and perspectives on injury prevention programs. *J Sci Med Sport.* 2016.

43. Guvenc G, Akyuz A, Açikel CH. Health belief model scale for cervical cancer and pap smear test: psychometric testing. *J Adv Nurs* 2011;67(2):428-437 410p.

44. Karayurt O, Dramali A. Adaptation of Champion's Health Belief Model Scale for Turkish women and evaluation of the selected variables associated with breast self-examination. *Cancer Nursing.* 2007;30(1):69-77 69p.

45. Kharameh ZT, Foroozanfar S, Zamanian H. Psychometric properties of the Persian version of Champion's Health Belief Model Scale for colorectal cancer screening. *Asian Pac J Cancer Prev.* 2014;15(11):4595-4599.

46. Medina-Shepherd R, Kleier JA. Spanish Translation and Adaptation of Victoria Champion's Health Belief Model Scales for Breast Cancer Screening - Mammography. *Cancer Nursing.* 2010;33(2):93-101 109p.

47. Frost AM DT, Langel JA, Klatt TH. Descriptive Epidemiology of Injuries and Illnesses at a University Wellness and Recreation Center: 1987-2006. Paper presented at: Research in the Capitol2007; Des Moines, IA.

48. Rosenstock IM, Strecher VJ, Becker MH. Social learning theory and the health belief model. *Health Educ Q.* 1988;15(2):175-183.

49. Houston M, Hoch J, Lunen B, et al. The development of summary components for the Disablement in the Physically Active scale in collegiate athletes. *Qual Life Res.* 2015;24(11):2657-2662.

50. Zigmond AS SR. The Hospital Anxiety and Depression Scale. *Acta Psychiatr Scan.* 1983;67:361-370.

51. Kroll T, Kehn M, Pei-Shu H, Groah S. The SCI Exercise Self-Efficacy Scale (ESES): development and psychometric properties. *Int J Behav Nutr Phys Act.* 2007;4:34-36.

52. Olssøn I, Mykletun A, Dahl AA. The hospital anxiety and depression rating scale: A cross-sectional study of psychometrics and case finding abilities in general practice. *BMC Psychiatry.* 2005;5:46-47.

53. Frank BS, Register-Mihalik J, Padua DA. High levels of coach intent to integrate a ACL injury prevention program into training does not translate to effective implementation. *J Sci Med Sport.* 2015;18(4):400-406.

54. Denegar CR, Hertel J, Fonseca J. The effect of lateral ankle sprain on dorsiflexion range of motion, posterior talar glide, and joint laxity. *J. Orthop Sports Phys Ther.* 2002;32(4):166-173.

55. Konradsen L, Olesen S, Hansen HM. Ankle sensorimotor control and eversion strength after acute ankle inversion injuries. *Am J Sports Med.* 1998;26(1):72-77.

56. Cozzi AL, Dunn KL, Harding JL, Valovich McLeod TC, Welch Bacon CE. Kinesiophobia After Anterior Cruciate Ligament Reconstruction in Physically Active Individuals. *J Sport Rehabil.* 2015;24(4):434-439.

57. Cole DW, Ginn TA, Chen GJ, et al. Cost Comparison of Anterior Cruciate Ligament Reconstruction: Autograft Versus Allograft. *Arthroscopy.* 2005;21(7):786-790.

58. Hartley EM HM, Cramer RJ. The Development of the Theory of Planned Behavior and Health Belief Model Scales:Assessing Behavioral Determinants of Exercise-Related Injury Prevention ProgramParticipation. *Athl Train Sports Health Care.* In Press.

59. DeVellis RF. *Scale development theory and applications.* 2nd ed.. ed. Thousand Oaks, Calif.: Thousand Oaks, Calif. : SAGE Publications; 2003.

60. Cohen J. *Statistical power analysis for the behavioral sciences.* 2nd ed.. ed. Hillsdale, N.J.: Hillsdale, N.J. : L. Erlbaum Associates; 1988.

61. Ferketich S. Focus on psychometrics: aspects of item analysis. *Res Nurs health.* 1991;14(2):165-168.

62. Distefano LJ, Distefano MJ, Frank BS, Clark MA, Padua DA. Comparison of integrated and isolated training on performance measures and neuromuscular control. *J Strength Cond Res.* 2013;27(4):1083-1090.

63. Noyes FR, Barber Westin SD. Anterior Cruciate Ligament Injury Prevention Training in Female Athletes: A Systematic Review of Injury Reduction and Results of Athletic Performance Tests. *Sports Health.* 2012;4(1):36-46.

64. Soligard T, Myklebust G, Steffen K, et al. Comprehensive warm-up programme to prevent injuries in young female footballers: cluster randomised controlled trial. *BMJ.* 2009:95-99 95p.

65. Hertel J. Sensorimotor deficits with ankle sprains and chronic ankle instability. *Clin Sports Med.* 2008;27(3):353.

66. Arnold BL, Wright CJ, Ross SE. Functional Ankle Instability and Health-Related Quality of Life. *J Athl Train.* 2011;46(6):634-641.

67. Gerber JP, Williams GN, Scoville CR, Arciero RA, Taylor DC. Persistent disability associated with ankle sprains: a prospective examination of an athletic population. *Foot Ankle Int.* 1998;19(10):653-660.

68. Nouni-Garcia R, Carratala-Munuera C, Orozco-Beltran D, Lopez-Pineda A, Asensio-Garcia MR, Gil-Guillen VF. Clinical benefit of the FIFA 11 programme for the prevention of hamstring and lateral ankle ligament injuries among amateur soccer players. *Injury Prevention.* 2017

69. Reis I, Rebelo A, Krustrup P, Brito J. Performance Enhancement Effects of Fédération Internationale de Football Association's "The 11+" Injury Prevention Training Program in Youth Futsal Players. *Clin J Sport Med.* 2013;23(4):318-320.

70. Steffen K, Emery CA, Romiti M, et al. High adherence to a neuromuscular injury prevention programme (FIFA 11+) improves functional balance and reduces injury risk in Canadian youth female football players: a cluster randomised trial. *Br J Sports Med.* 2013;47(12):794.

71. Barengo NC, Meneses-Echavez J, Ramirez-Velez R, Cohen DD, Tovar G, Bautista J. The Impact of the FIFA 11+Training Program on Injury Prevention in Football Players: A Systematic Review. In. *Int. J. Environ. Res. Public Health.* Vol 112014:11986-12000.

72. Brito J, Figueiredo P, Fernandes L, et al. Isokinetic strength effects of FIFA's "The 11+" injury prevention training programme. *Isokinet Exerc Sci* 2010;18(4):211-215.

73. Plisky PJ, Gorman PP, Butler RJ, Kiesel KB, Underwood FB, Elkins B. The reliability of an instrumented device for measuring components of the star excursion balance test. *N Am J Sports Phys Ther.* 2009;4(2):92-99.

74. Gribble PA, Terada M, Beard MQ, et al. Prediction of Lateral Ankle Sprains in Football Players Based on Clinical Tests and Body Mass Index. *Am J Sports Med.* 2016;44(2):460-467

75. Hartley EM, Hoch MC, Boling MC. Y-balance test performance and BMI are associated with ankle sprain injury in collegiate male athletes. *J Sci Med Sport.* 2017.

76. Smith CA, Chimera NJ, Warren M. Association of Y Balance Test Reach Asymmetry and Injury in Division I Athletes. *Med Sci Sports Exerc.* 2015;47(1):136-141.

77. Padua DA, Boling MC, Distefano LJ, Onate JA, Beutler AI, Marshall SW. Reliability of the landing error scoring system-real time, a clinical assessment tool of jump-landing biomechanics. *J Sport Rehabil.* 2011;20(2):145-156.

78. Padua DA, DiStefano LJ, Beutler AI, de la Motte SJ, DiStefano MJ, Marshall SW. The Landing Error Scoring System as a Screening Tool for an Anterior Cruciate Ligament Injury-Prevention Program in Elite-Youth Soccer Athletes. *J Athl Train.* 2015;50(6):589-595.

79. Pointer CE, Reems TD, Hartley EM, Hoch JM. The Ability of the Landing Error Scoring System to Detect Changes in Landing Mechanics: A Critically Appraised Topic. *Int J Athl Ther Train.* 2017;22(5):12-20.

80. Cohen J. *Statistical power analysis for the behavioral sciences.* Rev. ed.. ed. New York: New York : Academic Press; 1977.

81. O'Malley E, Murphy JC, McCarthy Persson U, Gissane C, Blake C. The effects of the GAA 15 training program on neuromuscular outcomes in Gaelic football and hurling players; a randomized cluster trial. *J Strength Cond Res.* 2016.

82. DiStefano LJ, Marshall SW, Padua DA, et al. The Effects of an Injury Prevention Program on Landing Biomechanics Over Time. *Am J Sports Med.* 2016;44(3):767-776.

83. Hoch MC, Welsch LA, Hartley EM, Powden CJ, Hoch JM. Y-Balance Test Performance Following a Competitive Field Hockey Season: A Pretest-Posttest Study. *J Sport Rehabil.* 2017:1-13.

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Publications

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Hartley EM, Hoch MC, Cramer RJ. The Development of the Theory of Planned Behavior and Health Belief Model Scales: Assessing Behavioral Determinants of Exercise-Related Injury Prevention Program Participation. *Athl Train Sports Health Care.* In Press